WEST VIRGINIA GEOLOGICAL SURVEY

PLATE I.—Seneca Rock at Mouth of Seneca.

WEST VIRGINIA

GEOLOGICAL SURVEY

Pendleton County

By

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I. C. WHITE, State Geologist

1927

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*Deceased, November 25, 1927.

LETTER OF TRANSMITTAL

To His Excellency, Hon. Howard M. Gore, Governor of West Virginia and President of the West Virginia Geological Survey Commission:

SIR:

I have the honor to transmit herewith the Detailed County Report and accompanying topographic and geologic map covering Pendleton County. This is one of our larger counties and its area is all situated within the region of high mountains, the culminating peak of West Virginia, Spruce Knob, whose summit rises to 4860 feet above sea-level, being located in this county. The South Potomac, the Cheat, the Greenbrier, the James, and the Shenandoah, all receive tributary streams from this elevated region. It is one of the two counties (Calhoun being the other) in the State that has no standard-gauge railways within its borders, the only one being narrow-gauge or temporary lumber railways upon which the immense timber resources of the county have been transported to sawmills and manufactured into marketable materials. It is also one of the few counties of the State that hold no valuable supplies of coal. However, it has vast deposits of limestone, much iron ore of low grade, abundant shales for brick-making, and possibly some deposits of glass-sand, since the Oriskany Sandstone, the same one that furnishes such large quantities of excellent glass-sand in the region of Berkeley Springs, Morgan County, W. Va., has extensive outcrops in many portions of Pendleton.

All of these geologic formations have been described by Drs. Tilton and Prouty, both aided by Paul H. Price of the Survey staff. The Survey was fortunate in securing the services of Dr. Wm. F. Prouty of the University of North Carolina to study and describe the older geologic formations of Pendleton County from the top of the White Medina down to the basal portion of the older rocks exposed at the surface on the great dome which brings up the upper members of the Shenandoah Limestones in the region, 1 to 2

miles northwest of Seneca Rocks. From this further study in addition to his previous work in Hardy County, adjoining Pendleton, Dr. Prouty is now convinced, in agreement with the writer's conclusion, that the dividing line between the Silurian and Ordovician formations should be placed at the junction of the Gray Medina Sandstones with the Martinsburg shales and sandstones and not at the top of the Red Medina as he was formerly inclined to believe. The part that each of the three men, Drs. Prouty, Tilton, and Price, took in the preparation of this Report is fully set forth in the succeeding pages.

Pendleton is the only county in West Virginia, so far as known, in which a dike of volcanic rock was thrust through the overlying stratified beds and reached the surface. The location and character of this interesting dike is described by Dr. Tilton on pages 266-273 of this Report. The Iron Ores of the county are abundant, but most of them are of low grade and very siliceous, so that their commercial exploitation must be deferred until a distant future when the richer and purer iron ores of the world have been largely exhausted.

The wonderful scenic outcrop of the celebrated "Seneca Rocks", near the mouth of Seneca Creek, where a great ledge of White Medina Sandstone rises vertically to a height of over 600 feet above the Potomac waters, has now been taken into the Monongahela National Forest along with a large surrounding area including the "Smoke Hole" country and when good roads shall have made this region readily accessible, it is sure to become a great resort for tourists and those who enjoy the outdoor life of grand mountain scenery.

The excellent soils and other natural resources of the county are fully described in this Report, and later a special Soil Report and Soil Map of the County will be prepared and published by a Soil expert of the Bureau of Soils of the U. S. Department of Agriculture.

Very respectfully,

I. C. WHITE,
State Geologist.

Morgantown, W. Va., Nov. 15, 1927.

CONTENTS

	Page
Members of Geological Survey Commission and State Board of Control	iii
Members of Scientific Staff	v
Letter of Transmittal	vi-vii
Table of Contents	viii-x
List of Illustrations	xi-xviii
Authors' Preface	xix-xx
Errata	

PART I. HISTORY, PHYSIOGRAPHY, AND WATER-POWER.

By Paul H. Price, Assistant Geologist.

Chapter I.—Historical and Industrial Development	1-22
Location	1-2
Transportation	2-8
Highways	3-8
General Description	8-20
Miscellaneous Items	8-20
Formation	8-9
Area	9-10
Relief	10
Climate	10-13
National Forests	13-15
Population	16-17
Products	17
Property Valuation	17-18
Postal Service	18-20
Towns and Industries	21-22
"Pendleton, My Pendleton"	22
Chapter II.—Physiography and Water-Power	23-59
Introduction	23-24
The Restored Surface	24-25
The Schooley Peneplain	25-30
Monadnocks on the Schooley Peneplain	25-30
Remnants of the Schooley Peneplain	29-30
Harrisburg Peneplain	30-32
River Terraces	32-36
Present Topographic Features	37-40
Drainage Basins	40-52
Table of Stream Data	40-43
Drainage Areas of Pendleton County	43-44
Description of Drainage Basins	44-52
Water-Power	52-59
Present Development	52-55
Available Streams	55-59
Indicated Horse-Power of Streams	57-59

PART II. GEOLOGY.

	Page
Chapter III.—Rocks of Pendleton County Below the Clinton	63-103
By Wm. F. Prouty.	
Introduction	60-61
White Medina (Tuscarora)	61-70
Red Medina	70-72
Gray Medina	72-73
Martinsburg Shale	74-78
Chambersburg Limestone	78-79
Stones River Limestone	79-80
Faults	80
Topography	80-81
Figures (Sections)	82-85
Description of Plates	86-87
Plates	88-103
Chapter IV.—The Geological Formations Above the Top of the White Medina	104-226
By John L. Tilton.	
Introduction	104-105
The Clinton Series	105-114
Niagara Series	114-119
Salina Series	120-132
Bloomsburg	120-124
Rondout	124-126
Bossardville	126-132
The Devonian System	132-177
Lower Devonian	133-147
Helderberg Series	134-141
Oriskany Series	141-147
Middle Devonian	147-159
Section and Map	147-148
Marcellus Series	149-154
Hamilton Series	154-159
Upper Devonian	159-177
Upper Devonian Section	159-160
Genesée Series	160-167
Portage Series	167-171
Chemung Series	171-174
Catskill Series	174-177
The Mississippian System	177-205
Section	177-178
The Pocono Series	178-186
The Greenbrier Series	187-192
The Mauch Chunk Series	192-205
The Pennsylvanian System	206-213
The Pottsville Series	206-213
The Pleistocene and Recent System	213-226
Chapter V.—The Geologic Structure	227-265
By John L. Tilton.	
Terms Used	227-230
The Structure in General	231-234
The Shenandoah Mountain Synclinal Area	235
The Elkhorn Mountain-Long Ridge Anticlinal Area	235-236
The Middle Mountain ("Trough") Synclinal Area	236-237
The Wills Mountain Anticlinal Area	237-238

The Stony River-Wellersburg Synclinal Area............ 238-240
The Cross-Sections 240-244
Faults 244-250
Out from Franklin................................ 251-265
North 251-254
Down into Smoke Hole.......................... 254-257
South 257-258
East 258-259
West 259-265

Chapter VI.—An Igneous Dike of Altered and Extremely Weathered Volcanic Breccia.................... 266-273
By John L. Tilton.

PART III. MINERAL RESOURCES.

By John L. Tilton.

Chapter VII.—Economic Geology......................... 274-316
Iron Ores 274-281
Clinton Series................................ 274-279
Oriskany Series............................... 279-280
Manganese 280-281
With Reference to Coal, Oil, and Gas.................. 281-285
Coal 281-285
Oil and Gas................................... 285
Limestone 286-292
Shale and Clay..................................... 292-293
Sandstone, Sand, and Gravel........................ 293-296
Road Material...................................... 296-301
Water for Domestic Purposes........................ 301-305
The Soils 305-307
Forest Conditions.................................. 308-313
List of Collections and Analyses................... 314-316

Appendix—Levels Above Mean Tide........................ 317-358
By R. C. Tucker.
United States Geological Survey Levels................. 317-358
Circleville Quadrangle........................ 319-326
Fort Seybert Quadrangle....................... 326-328
Horton Quadrangle............................. 328-337
McDowell Quadrangle........................... 338-339
Onego Quadrangle.............................. 340-346
Petersburg Quadrangle......................... 346-353
Spruce Knob Quadrangle........................ 353-358

Index.. 359-384

ILLUSTRATIONS.

Maps I and II in Atlas (Under Separate Cover).

Map I.—Showing Topography of Pendleton County.
Map II.—Showing General and Economic Geology of Pendleton County, with Cross-Sections.

Plates.

No.	Page.
I.—Seneca Rock at Mouth of Seneca....................	Frontispiece
II.—A view of Franklin looking north. The even-crested sky-line represents the Harrisburg Peneplain. (See Plate V for view of Franklin looking south)................	20
III.—Profile model showing physiographic features of county..	26
IV.—A view east from Oak Flat. The lower line of ridges marks the Harrisburg Peneplain while the Shenandoah Mountain in the background marks the Schooley Peneplain	28
V.—View of Franklin looking south. The even-crested sky-line marks the dissected Harrisburg Peneplain..............	31
VI.—"Reunion Grounds". Here the flood-plain of Thorn Creek makes an inviting place for campers....................	33
VII.—View from County Farm looking north across the flood-plain and terraces of the South Branch. Upper Tract can be seen in the extreme left........................	34
VIII.—Mouth of Seneca. There is a flood-plain seven feet above the river. The terrace on which the houses are built stands twenty feet above the river. The high terrace is 110 feet above the low terrace, and about half-way between these two terraces is an inconspicuous terrace. The line of River Knobs appears at the right. The picture is taken from the second terrace just south of Mouth of Seneca, looking northeast....................	36
IX.—View from top of Seneca Rock, to the northwest. In the foreground is the North Fork River. The prominent relief in the middle background is Smith Mountain. In the extreme right and left background can be seen Roaring Plains marking the Allegheny Front............	51
X.—Kline Mill. Here the miller is utilizing the water of Mill Run as it falls over an Oriskany Sandstone ledge to propel a 30-foot diameter overshot wheel..................	53
XI.—Ketterman Mill on Brushy Run, where the water comes from a cave in the Greenbrier Limestone. This is an old-time mill site..	54
XII.—A view from the top of Seneca Rock east along the rocks	63

No.		Page.
XIII.	—View from back of Seneca Rock looking west. Fore Knobs can be seen through the gap on the left..........	64
XIV.	—A view of what is known locally as the Cathedral Arch of the Seneca Rocks..................................	65
XV.	—The limestone valley lying east of Seneca Rock and west of North Fork Mountain..........................	66
XVI.	—Contact between Red and Gray Medina is to be seen at the right end of the board which overlies a portion of the stream in the left foreground of the picture. The rocks are here shown with an easterly dip. This is due to overturning on the west side of the great Wills Mountain Anticline. Locality, Circleville Gap....................	88
XVII.	—Low-angle fault-plane cutting the Chambersburg and Stones River Limestones in the neighborhood of Key, Germany Settlement. The photograph shows slickensides in the calcite filling along the fault-plane. These slickensides are found to trend in different directions in the different layers of the calcite, showing apparently a succession of movements in slightly different directions. This photograph shows the fault-plane to have a slight western dip, but in most places it has a low-angle eastern dip..	89
XVIII.	—Bottom of Gray Medina and top of Martinsburg Shales. The contact between the two runs diagonally across the picture from southeast to northwest, passing under the shed in the central part of the picture. The overturned east-dipping Gray Medina is to be seen in the foreground of the picture, the lower portion of it making a small water-fall. The Lingula zone of the Martinsburg extends up the stream as far as the foot-bridge. Locality, Circleville Gap..	90
XIX.	—Calcareous shales and hard cobbly limestone in the Prasopora zone (Trenton), Circleville Gap..............	91
XX.	—View of the White Medina Sandstone from the Franklin-Harrisonburg road near Hardscrabble Church..........	92
XXI.	—The vertical bed of White Medina in Riverton Gap. This bed represents the middle portion of the White Medina, which is everywhere through this region the most resistant part and which is the ridge-forming sandstone..	93
XXII.	—Harmon Rocks from the new county road, northwest side of North Fork Mountain. The Rocks represent the resistant portion of the White Medina which are here fantastically outlined against the sky-line. Between the Rocks and the road in the foreground come in the Red Medina, the Gray Medina, and the upper portion of the Martinsburg..	94

No. Page.

XXIII.—Martinsburg Shale slopes, Noah Teter Hollow. Here the land is not too steep to prevent plowing and growing of crops, but in most places the slopes are so steep that it is more profitable to use the land for grazing. Chestnut trees grow naturally in this soil........................ 95

XXIV.—Side view of White Medina "wall". This picture shows the same ridge as that seen in Plate XXI. Riverton Gap.. 96

XXV.—Harmon Rocks. View looking southeast along the strike from just north of the new county road, showing portions of White Medina and Red Medina in profile. The Red Medina comes in below the western crest of the hill (left of picture). The presence in it here of a resistant gray sandstone is well shown by the bench in the right-hand portion of the picture. This gray sandstone bed crosses the county road just below the high point in the gap. Note the abundance of chestnut trees.................. 97

XXVI.—Noah Teter Hollow looking west. Wall of White Medina Sandstone is to be seen in left background. Contact of Gray Medina and Martinsburg forms sky-line in right-hand portion of picture. Bottom of Orthorhynchula Zone is in lower right-hand corner of picture................ 98

XXVII.—View of Seneca Rock, looking east through Seneca Rock Gap into the valley of Wills Mountain Anticline. In the background can be seen the crest of North Fork Mountain which is capped by the Medina Sandstone, the same formation as that of Seneca Rock. These two ridges represent opposite limbs of the same fold and are over two miles apart. View taken from highway a little south of Mouth of Seneca....................... 99

XXVIII.—Panoramic view through 180 degrees from northeast through northwest to southwest, taken from new county road on west side near crest of North Fork Mountain. Between North Fork Mountain and the first range of hills to the northwest is the Wills Mountain anticlinal valley. This valley toward the southwest (left) is composed entirely of Martinsburg Shale, but toward the north the older limestones beneath the Martinsburg come back to the surface. The first ridge to the northwest is the "River Knobs" formed by vertical Medina Sandstone in west limb of Wills Mountain Anticline. The next range of hills to the northwest is held up by the less steeply dipping Oriskany Sandstone, and the high ridge in the background is held up by Carboniferous sandstone in the center of the great Stony River Syncline. In the first ridge toward the southwest the vertical wall of White Medina Sandstone can be readily seen in Riverton Gap. (Right-hand edge of top fits at left-hand edge of center view, while right-hand edge of center fits left-hand edge of bottom view)........................... 100

No. Page.

XXIX.—View of low-angle fault with three-foot calcite bed along the fault-plane. About 200 feet southeast of Key. This fault continues for at least two miles along the strike, in this area. Waters from the overlying limestones have percolated along this fault in the past and precipitated the thick bed of calcite. In many places in the overlying limestones, caverns and sinks are to be found. The sink shown in Plate XXX is about 250 feet from this locality and in the overlying Stones River Limestone.......... 101

XXX.—A small sink in the bed of a now dry branch about 450 feet southeast of Key, and about 250 feet southeast of the fault shown in Plate XXIX. The water from this sink evidently finds an outlet along the fault-plane shown in Plate XXIX. Many such passages probably lead to the great spring a little to the north of here (Judy Spring or McDonald Spring).......... 102

XXXI.—Mushroom or pedestal rock found about 4,000 feet southeast from Key up the branch and just below the point where the branch crosses the road leading down the mountain into Germany Settlement. This rock is made of petroliferous Chambersburg Limestone.......... 103

XXXII.—Keefer Sandstone, 0.3 mile south of Dickinson Mountain School.......... 110

XXXIII.—Bloomsburg Sandstone, near fault-line in Smoke Hole. 121

XXXIV.—Bloomsburg Sandstone, 1 mile east of Kline Post-Office.......... 122

XXXV.—Camarotoechia andrewsi and Hindella congregata zone of Bossardville Limestone, 5 miles east of Friends Run School.......... 128

XXXVI.—Burning lime from the Bossardville Limestone, along Hammer Run 1 mile west of Ruddle.......... 129

XXXVII.—An Oriskany-Helderberg arch cut through by Thorn Creek, 0.3 mile south of Franklin. In the left center the Oriskany can be seen almost vertical and near the center the New Scotland Chert and Coeymans Limestone are almost horizontal. A Marcellus valley in the foreground. 137

XXXVIII.—An excellent exposure of New Scotland Chert and Coeymans Limestone at "Bluehole" where the South Branch has cut through an arch of Oriskany and Helderberg.......... 138

XXXIX.—New Scotland Chert, showing Spirifer macropleurus. East limb of Big Mountain entering Smoke Hole.......... 139

No.		Page.
XL.	—Oriskany Sandstone, slightly overturned, west limb of Cave Mountain entering Smoke Hole	144
XLI.	—Oriskany Sandstone, Smoke Hole Settlement	145
XLII.	—Hamilton Shales. Fossil collection here. 0.3 mile south of Brushy Run Post-Office	156
XLIII.	—Genesee Shales at Brandywine	163
XLIV.	—Portage Sandstones and Shales along South Fork River east of Wilfong Church	170
XLV.	—Pocono Conglomerate along Seneca Creek at bridge south of Onego	185
XLVI.	—Water in Roaring Creek flowing over Cypress Sandstone at Roaring School	190
XLVII.	—Webster Springs Sandstone making falls 0.6 mile from mouth of Long Run	198
XLVIII.	—Where Long Run crosses the Hinton (Avis) Limestone	199
IL.	—Top of the Reynolds Limestone where crossed by Long Run about a mile northeast of Haystack Knob	200
L.	—Mauch Chunk Shale and Sandstone on the side of Green Knob. Green Knob is on the county line northeast of Mouth of Seneca. Its elevation is 4660 feet A. T. Its rocky summit is covered with ancient trees, logs, and a tangle of brush	201
LI.	—Looking along the ridge that divides the waters of Cheat River from those of the North Fork of the South Branch of the Potomac. Green Knob with an elevation of 4660 feet A. T. is seen in the center background	207
LII.	—View of the Allegheny Front from the Timber Ridge road three miles south of Onego	208
LIII.	—Roaring Plains capped by the Pottsville Conglomerate. This level marking the Schooley Peneplain is approximately 4600 feet A. T. It also marks the Allegheny Front	209
LIV.	—Spruce Knob, the highest point in the State, 4860 feet A. T. The cap rock upon which is located a lookout is the Sharon Conglomerate of the Pottsville Series. Note the limbs of the trees pointing to the northeast. This area probably represents a monadnock above the Schooley Peneplain	210

No. Page.

LV.—Haystack Knob, with its remnant of Pottsville Conglomerate, is a conspicuous feature from all directions. It is situated on the county line northwest of Mouth of Seneca. Along its side the old Indian trail passes from Seneca Rock to the northwest. In the background is the line of cliffs along Roaring Plains, capped by Pottsville Conglomerate.... 211

LVI.—The second ledge of Pocono sandstone at the mouth of Roaring Creek. Close by is Onego.... 212

LVII.—Pottsville (Sharon Conglomerate), top of Roaring Plains.... 214

LVIII.—Pottsville Conglomerate with Spruce Knob in the immediate background.... 215

LIX.—View east from top of Mauch Chunk, 4250 A. T., at head of Long Run, looking toward Roaring Plains.... 216

LX.—Roaring Plains, as seen from one of the lower ledges on Long Run.... 217

LXI.—Consolidated terrace deposits of South Fork River, 0.5 mile south of Sugar Grove.... 221

LXII.—River Terrace. This view shows the second terrace of the South Branch resting upon Marcellus Shale, south of Ruddle. The terrace is 30 feet above the first or low terrace.... 222

LXIII.—A view from 0.6 mile southeast of Wilfong Church facing east, showing first, second, and third terraces of South Fork River.... 224

LXIV.—One of the three entrances to Trout Cave in the face of a cliff of New Scotland Limestone three and a half miles southwest of Franklin, on the north side of the road and at a place 250 feet above the roadway.... 225

LXV.—Entering Smoke Hole Settlement showing unsymmetrical arch, west limb slightly overturned, east limb in right background.... 229

LXVI.—Small arch in Oriskany Sandstone, Smoke Hole Settlement.... 230

LXVII.—Scenery across the ridges. View from Mt. Horeb Church looking west to North Fork, Big, and Cave Mountains.... 233

LXVIII.—Scenery across the ridges. View east from "Dolly Trail" with Peters Mountain in the foreground.... 234

LXIX.—Panoramic view of Seneca Rock at Mouth of Seneca. Top view fits left-hand edge of lower view.... 239

No.	Page.
LXX.—Looking east, White Medina along fault-line on Castle Mountain	245
LXXI.—Looking east, White Medina along fault-line on Ruleman Mountain	246
LXXII.—Fire "Lookout" and cabin on Shenandoah Mountain, east of Sugar Grove	260
LXXIII.—View southwest from tower on Shenandoah Mountain	261
LXXIV.—Road cut through White Medina Sandstone along the new State route from Franklin to Mouth of Seneca, on east side of North Fork Mountain	263
LXXV.—Igneous Dike, 0.4 mile north of Virginia State line, and 0.8 mile west of Bull Pasture Mountain	268
LXXVI.—Knob made by Igneous Dike	269
LXXVII.—Where the lowermost coal outcrops about half-way up landslide run	282
LXXVIII.—Marl deposited over Rondout. The location is on Friends Run, half a mile east of Friends Run School	288
LXXIX.—This building represents a complete geologic column of the more resistant rocks of Pendleton County from the Pottsville to the Ordovician	295
LXXX.—Lumber engine in use along the headwaters of Seneca Creek	309

Figures.

No.	Page.
1.—Outline Map of West Virginia showing Progress of Detailed County Surveys	xx
2.—Outline Map of West Virginia showing Pendleton County Area	xx
3.—Map of Pendleton County showing National Forests	15
4.—Map of Pendleton County showing Drainage System	41
5.—Map of Pendleton County showing Medina Sandstones	68
6.—Map of Pendleton County showing Ordovician Rocks	75
7.—Section through central portion of Wills Mountain Anticline showing the older limestones and low-angle faults. Near Key, northeast portion of Germany Settlement	82
8.—Typical cross-section through Wills Mountain Anticline, North Germany Settlement	82
9.—Section through gap between Simmons Mountain and Brushy Mountain	82
10.—Hardscrabble Church Section	83
11.—Profile section through Wills Mountain Anticline, along old Franklin-Circleville road	83
12.—Profile section through Medina-Clinton Ridge, Props Run road, 2 miles southeast of Franklin	83
13.—Section through Castle Mountain	84
14.—Typical profile through the Medina Sandstones and the bordering shales	84
15.—Cross-section through a portion of Noah Teter Hollow	84
16.—Typical limestone lens or reef in shales of the lower portion of Eden Division of Martinsburg	85
17.—Riverton Gap Section	85
18.—Circleville Gap Section	85
19.—Typical section of portion of lower-middle Red Medina, Circleville Gap	85
20.—Map of Pendleton County showing Silurian Limestones	115
21.—Map of Pendleton County showing Lower Devonian Rocks	135
22.—Map of Pendleton County showing Middle Devonian Rocks	148
23.—Map of Pendleton County showing Upper Devonian Rocks	161
24.—Map of Pendleton County showing Carboniferous Rocks	179
25.—Map of Pendleton County showing Iron-Bearing Series	276

AUTHORS' PREFACE

The report on the geology of Pendleton County is the result of the collaboration of three persons: To William F. Prouty was assigned all below the top of the White Medina (or below the Clinton), to John L. Tilton all strata above the White Medina, and to Paul H. Price the illustrations, the historical and industrial development, the physiography, the drafting of the geologic maps and cross-sections and paleographic maps showing geologic series, the drainage and other related data, water-power, and National Forests. The field work was accomplished in the summers of 1924 and 1925, Mr. Price working with Dr. Prouty in the summer of 1924 and with Dr. Tilton in the summer of 1925. In the field mapping it was found impractical for either party to confine the geological mapping entirely to the formations assigned, but each is responsible for the *general geology* and the geological mapping of his respective division.

As published, Part I, including Chapters I and II, were written by Paul H. Price; Chapter III, of Part II, was written by Dr. Prouty; while Chapters IV, V, and VI, of Part II, and Chapter VII, Part III, were written by Dr. Tilton. The Appendix was prepared by R. C. Tucker, Assistant Geologist, as was also the Index and Introductory Matter. To Mr. Tucker was also assigned the editorial arrangement of the manuscripts, the reading of the proof, etc.

The authors express their obligation to Dr. I. C. White, State Geologist, whose constant supervision, most kindly criticisms, and instructive suggestions have added greatly to the value of this Report.

JOHN L. TILTON.
WM. F. PROUTY.

Morgantown, W. Va., July 1, 1927.

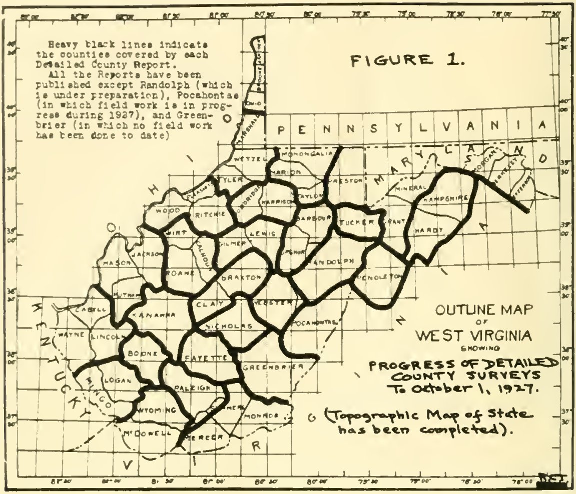

Figure 1.—Outline Map of West Virginia Showing Progress of Detailed County Surveys.

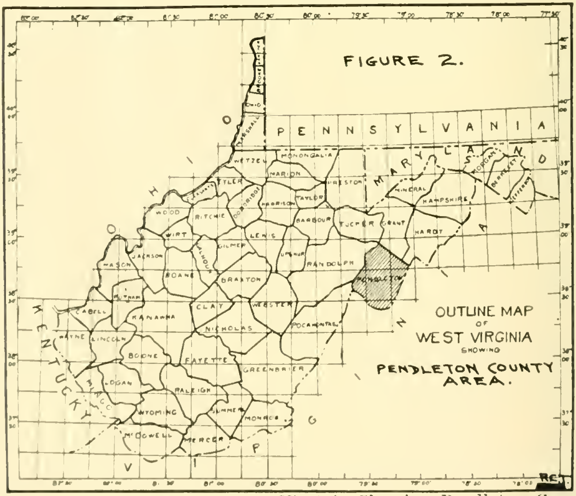

Figure 2.—Outline Map of West Virginia Showing Pendleton County Area.

PART I.

History, Physiography, and Water-Power.

By Paul H. Price, Assistant Geologist.

CHAPTER I.

HISTORICAL AND INDUSTRIAL DEVELOPMENT.

LOCATION.

Pendleton County, the area treated in this Report, lies in the eastern part of the State just north of center. It is one of the border counties with Virginia and its eastern and southern limits form the State boundary line with that of Virginia. It lies between the parallels 38° 24′ 45″ and 38° 57′ 30″ north Latitude and the meridians 79° 3′ 30″ and 79° 37′ 30″ west Longitude from Greenwich. Pendleton County has the shape of a rectangle, so placed that a line running north and south, starting at the northeast corner, will divide the county roughly into two equal right-angle triangles. It is bounded on the north by Grant and Hardy Counties, West

Virginia; on the east and south by Rockingham, Augusta, and Highland Counties, Virginia, and on the west by Pocahontas and Randolph Counties, West Virginia. The northern and southern boundaries are artificial ones connecting the natural boundaries on the east and west. On the east the crest of the Shenandoah Mountain makes a natural boundary while the Allegheny Front of the Allegheny Mountain marks the western boundary. The greatest distance across the county from east to west is twenty-five and one-half miles and the greatest distance from north to south is thirty-eight miles.

The geographical position of the county can be seen on Figure 1 of this Report, and more in detail on Map I, accompanying this volume.

TRANSPORTATION.

At present transportation is one of the problems of the people of Pendleton County. Although blessed with rivers, no use has been made of them for transportation since the early days, and then only during the rainy season to float rafts to market.

Pendleton is the one county of the State that has no standard-gauge railroad. Several unsuccessful attempts have been made to promote a railroad in the county, but for various reasons each attempt has met with failure. In the western part of the county there are many miles of narrow gauge that is used in taking out the timber, but this is not permanent and is moved to new locations as the timber is cut down.

At this time the nearest points of railway are, the Petersburg Branch of the Baltimore and Ohio at Petersburg, Grant County; the Baltimore and Ohio at Harrisonburg and Staunton, Virginia, with the Chesapeake and Ohio also at Staunton and Hot Springs, Virginia. On the west the nearest access to a railroad is at Harman and Horton in Randolph County. This road is called the Central West Virginia and Southern, which connects with the Western Maryland at Hendricks. It does look as though Pendleton could well support a branch road at least. Because of the natural mountain barriers a railroad across the county from east to west is highly im-

probable. A railroad, however, paralleling the valleys and following the course of the South Branch River almost entirely across the county is highly possible. A branch from the Baltimore and Ohio at Petersburg to Hot Springs, Virginia, and there connecting with the Chesapeake and Ohio would be an outlet in both directions, and a great blessing to the people of the areas concerned. The natural obstructions to this project would not be prohibitive.

The principal mode of transportation is automobiles which have replaced the horse almost entirely. Good roads are largely responsible for this situation.

Highways.

With neither railroads nor waterways as a means of transportation, it is necessary that the highways be used entirely. In this respect Pendleton is fairly well off, or at least will be at the end of the present road-building program. There is no hard-surfaced road in the county, but the improved road from Petersburg to Franklin is kept in good condition the year round. The road from Franklin south to Monterey is now under construction. On the road east and west across the county several miles have been completed. East via Trout Run about five and one-half miles have been completed. On the road west to the North Fork area, the road is now completed to the top of North Fork Mountain and the contract has been let for the completion of this road to the river via Judy Gap.

It is the plan of the State Road Commission to improve the State Routes north, south, east, and west from the county-seat to the main highways of travel.

Mr. B. E. Gray, Division Engineer, located at Keyser, gives the following information regarding the State Routes in Pendleton County:

"At a meeting of the State Road Commission held in its office in the city of Charleston on the 4th day of August, 1921, the following order was passed and entered of record:

"'Ordered that in accordance with Chapter 112 of the Acts of 1921, the following State Routes be designated as such in Pendleton County:

"'Beginning at the Virginia State line on the Franklin-Monterey road; thence northerly via Franklin and Upper Tract to the Grant County line on the Franklin-Petersburg road.

"'Beginning at the Randolph County line near Harperton; thence easterly by the most practicable route via Franklin and Brandywine to the Virginia State line.'"

The following data concerning road work in Pendleton County are taken from pages 124-125 of the Annual Report of the State Road Commission for the fiscal year ending June 30, 1926:

County-District Road Work.

Under construction at the end of fiscal year: None.
Completed during fiscal year: None.
Completed prior to fiscal year: None.

County Financial Data.

Bonds voted during fiscal year: None.
County Road Levy..............................$14,971.08

State Road Work Done by State.

Under construction at end of fiscal year:
Project 3213—Franklin-Monterey—5.06 miles shale and gravel.
Project 3175C—Franklin-North Fork—5.82 miles grading.
Project 3208—Franklin-Brandywine—3.09 miles shale.
Completed during fiscal year:
Project 3175A—Franklin-Elkins—4.38 miles gravel.
Project 3175B—Franklin-North Mountain—4.44 miles gravel.

State Road Work Done by County.

None.

State Funds Apportioned.

State Bonds	$812,834.00
Federal Aid	23,842.68
Total	$836,676.68
Authorized for construction	$746,115.72

Under State Maintenance.

Project 3—Petersburg-Franklin—6.2 miles graded.
Project 3A—Route No. 53—0.75 mile gravel.
Project 3S—Ruddle-Upper Tract—2.10 miles gravel and 1.0 mile bituminous treated gravel.
Project 3105—Ruddle-Upper Tract—3.7 miles gravel.
Project 3175A—Franklin-West—4.38 miles gravel.
Project 3014—Upper Tract-Grant line—5.71 miles graded.
Project 3105—Reeds Creek Bridge No. 828.
Project 3014—Mill Creek Bridge No. 809.

Project 3142—Franklin-Brandywine—5.44 miles gravel.
Project 3014—Upper Tract Bridge No. 876.
Project 3175B—Franklin-North Mountain—4.44 miles gravel.
On State Route Not Taken Over: None.

The apportionment of State Fund and Federal Aid is made on a mileage basis. In a table on pages 164-5 of the Report mentioned, Pendleton is listed as having 95 miles of Class "A" Roads and 88.27 miles of State Routes.

Of the amount authorized ($746,115.72) for construction, the following sums were to be disbursed for the items mentioned, as shown in Appendix 9, opposite page 202, of the Report mentioned:

Survey, Plans, and Advert: Roads	$ 26,051.19
Grading and Draining	606,110.59
Paving	46,127.95
Bridges, Substructure	22,287.13
Bridges, Superstructure	31,723.72
Reconstruction	13,815.14
Total	$746,115.72

The distribution of authorizations by State Routes in Pendleton County, pages 205 and 206 of the Report mentioned, shows that $290,076.90 was to be expended on Route 28 (the north-south road), while $456,038.82 was to be spent on Route 53 (the east-west road).

Data on State Aid Projects.

The following data are taken from Appendix 3, pages 168-169, of the Annual Report of the State Road Commission for the year ending June 30, 1926:

Project No. 1035.—Petersburg-Franklin road. Type: Earth.

Length in miles	2.10
Cost of draining and grading	$57,892.47
Total cost per mile	$27,568.00
State Aid	$39,358.00
Amount aid paid	$39,358.00
Per cent. complete	100

Project No. 1082.—Franklin-Monterey road. Bridge.

Cost of draining and grading	$3,781.10
State Aid	$1,890.55
Amount aid paid	$1,890.55
Per cent. complete	100

Data on Federal Aid Projects.

From Appendix 4, page 172, of the above-mentioned Report of the State Road Commission, the following data are taken:

Project No. 3A.—Franklin-Ruddle road. Type: Earth.

Length in miles	4.20
Estimated cost	$33,565.26
Federal Aid	$14,972.10
Status	Complete

Project No. 3B.—Ruddle-Poor Farm road. Type: Earth.

Length in miles	2.10
Estimated cost	$32,835.00
Federal Aid	$16,417.40
State Fund	$ 8,558.93
Status	Complete

Data on State Projects.

The following data on State Projects are taken from Appendix 5 of the Report of the State Road Commission for 1925-1926, pages 179, 181, 184, 185, 186, 187, and 188:

Project No. 38.—Franklin-Petersburg road. Type: Gravel 2.1; Earth 1.0.

Length in miles	3.10
Cost of grading and draining	$15,300.64
Cost of paving	$10,000.00
Total amount of authorization	$25,300.64
Cubic yards excavation, unclassified	4,500
Price per yard	$1.00
Status	100% Complete

Project No. 1035.—Surveys and Plans.

Total amount of authorization	$300.00

Project No. 3014.—Franklin-Petersburg road. Bridges.

Total amount of authorization	$48,323.70
Status	100% Complete

Project No. 3105.—Poor Farm-Upper Tract road. Type: Gravel.

Length in miles	3.7
Cost of grading and draining	$21,053.53
Cost of paving	$25,497.24
Total cost per mile	$12,581.55
Total amount of authorization	$46,551.77
Cubic yards excavation, unclassified	21,890
Price per yard	$0.75
Status	100% Complete

Project No. 3105.—Poor Farm-Upper Tract road. Bridge.
Total amount of authorization....................$5,735.38
Status ....100% Complete

Project No. 3106.—Plans and Surveys.
Total amount of authorization......................$800.00

Project No. 3142.—Franklin-Brandywine road. Type: Gravel.

Length in miles	5.44
Cost of grading and draining	$90,821.87
Cost of paving	$ 7,011.67
Total cost per mile	$17,984.10
Total amount of authorization	$97,833.54
Cubic yards excavation, unclassified	47,767
Price per yard	$1.00
Status	100% Complete

Project No. 3175A.—Franklin-Elkins Road. Type: Gravel.

Length in miles	4.38
Cost of grading and draining	$74,252.79
Cost of paving	$18,728.74
Total cost per mile	$21,208.11
Total amount of authorization	$92,891.53
Cubic yards excavation, unclassified	39,500
Price per yard	$0.70
Status	100% Complete

Project No. 3175B.—Franklin-Elkins road. Type: Gravel.

Length in miles	4.44
Cost of grading and draining	$55,894.90
Cost of paving	$26,305.10
Total cost per mile	$18,288.28
Total amount of authorization	$81,200.00
Cubic yards excavation, unclassified	43,000
Price per yard	$0.90
Status	100% Complete

Project No. 3175C.—Franklin-Elkins road. Type: Earth.

Length in miles	5.82
Cost of grading and draining	$120,669.25
Total cost per mile	$ 20,733.54
Total amount of authorization	$120,669.25
Cubic yards excavation, unclassified	110,000
Price per yard	$0.64
Status	49% Complete

Project No. 3208.—Franklin-Brandywine road. Type: Shale.

Length in miles	3.09
Cost of grading and draining	$60,520.00
Cost of paving	$ 3,080.00
Total cost per mile	$20,582.52
Total amount of authorization	$63,600.00
Cubic yards excavation, unclassified	62,000
Price per yard	$0.63
Status	21% Complete

Project No. 3213.—Franklin-Monterey road. Type: Gravel and Shale.

Length in miles	5.06
Cost of grading and draining	$60,433.50

Cost of paving	$ 9,500.00
Total cost per mile	$13,820.84
Total amount of authorization	$69,933.50
Cubic yards excavation, unclassified	50,000
Price per yard	$0.74
Status	57% Complete

GENERAL DESCRIPTION.

MISCELLANEOUS ITEMS.

Formation.—From Oren F. Morton's "History of Pendleton County" the following account is taken:

"At the close of 1787 the population of Rockingham was nearly 7000, including about 700 slaves. With at least two-fifths of its area lying beyond the high, broad, and infertile Shenandoah Mountains, the time had come when it was too inconvenient to travel from thirty to sixty miles to reach the court-house. Accordingly the State Legislature passed, December 4th, 1787, the following Act:

"1. Be it enacted by the General Assembly, That from and after the first day of May next, all those parts of the counties of Augusta, Hardy, and Rockingham within the following bounds to-wit: Beginning on the line of Rockingham County on the North Mountain, opposite to Charles Wilson's on the South Fork, thence a straight line to Clay Lick on the North Fork, thence to the top of the Alleghany, and along the same and the east side of the Greenbrier waters to the southwest fountain of the South Branch, and thence between the same and the waters of James River, along the dividing ridge to the said North Mountain, and with the top of the same to the beginning, shall form one distinct county, and be called and known by the name of Pendleton."

Hence Pendleton as a county was formed seventy-six years before West Virginia became a State.

Within the limits defined by the above Act the area of Pendleton was considerably greater than it is at present. On the east, north, and west the original boundaries have remained unchanged. On the south there have been two subsequent changes. The original boundary included the northern portion of the Crabbottom and all the rest of the present county of Highland that lies north of the watershed between the streams that flow into the Potomac and those forming the upper basin of James River.

From Morton's History the next change in the southern boundary is given as follows:

"The line between Pendleton and Bath is thus defined by the County Surveyor in 1792: 'Beginning at the top of North Mountain opposite the lower end of John Redmond's land and the Cowpasture, and N. 63½ degrees W., crossing Shaw's Fork through the lands and below the dwelling house of Thomas Devereux, and crossing the Cowpasture Run through the lands and below the dwelling house of Joseph Mathew, and crossing the Crab Run about 2½ miles above the Blue Hole; and thence to the top of the Chestnut Ridge through the lands of William Lewis, and thence through the lands of Adam Boyers; thence crossing Back Creek and the Laurel Fork to the top of the Alleghany Mountain to a red oak and maple on top of said mountain; containing 20½ miles(?).'"

This southern boundary, however, stood only eight years. In 1796 another line was established, running through the center of what is now Highland, and giving Pendleton an area of 990 square miles.

"All that part of the county of Bath within the following bounds, to-wit: beginning at the top of the Alleghany Mountain, the northwest side of the line of the county of Pendleton, thence a straight line to the lower end of John Slavin's plantation on Greenbrier River, thence to Dinwiddie's Gap on Jackson's River, thence crossing the Bullpasture so as to leave Edward Stewart in the county of Bath, thence to Stewart's Gap on the Cowpasture, thence to the top of the mountain which divides the waters of the Cowpasture and Calfpasture Rivers, thence a northeasterly course along the said mountain to the line of the county of Pendleton."

The above boundary held until March 19, 1847, when the following Act was passed:

"Beginning where the North River Gap road crosses the Augusta County line, and running thence to the top of Jackson's Mountain, so as to leave Jacob Hiner's mansion house in Pendleton County; thence to Andrew Fleisher's so as to include his mansion house in the new county; thence to the highland between Dry Run and Crabbottom; thence along the top of the main ridge of said highlands to the top of the High Knob; thence N. 65° W. to Pocahontas County line."

This was the last change in boundary and was so taken over in the formation of the new State in 1863.

Area.—The area of Pendleton County as computed with planimeter by the writer (Price) from the topographic quadrangles of the U. S. Geological Survey is as follows:

District.	Square Miles.
Bethel	105.241
Circleville	101.773

	Square Miles.
Franklin	136.041
Mill Run	104.114
Sugar Grove	115.096
Union	134.610
Total	696.875

This shows Pendleton to be the fourth largest county in the State, there being only three larger, Greenbrier, Randolph, and Pocahontas.

Relief.—Pendleton County stands out as having the most rugged relief of any of the counties in the State. The causes for this rugged relief will be discussed more in detail under the Chapter on Physiography. The present relief is the result of long ages of erosion. The South Branch River and its various tributaries have cut deep valleys from the south end to the north end of the county, and have removed enough sediment from the county to bring the present elevations to a minimum of 4,000 feet if it could be replaced. At present the county varies in elevation from 4,860 feet on Spruce Knob, the highest point in the State, to 1,155 feet, the South Branch River level at the Pendleton-Grant County line, or a difference in elevation of 3,705 feet. Along the Shenandoah Mountain on the east, elevations of over 4,000 feet are reached, while on the western side of the county, the Allegheny Front has many points well above 4,500 feet.

Climate.—Due to the absence of complete weather records it is possible to speak of the climate only in a general way. The mean altitude is about 3,000 feet. The topography is roughly, mountains and valleys, with the only comparatively level land near Upper Tract. The valleys, in which most of the inhabitants live, are protected by the mountains on either side, and consequently the winters are not severe in the lowlands. According to local information, the rains do not follow the mountains as might be expected, but come from the southwest, and consequently very seldom cause disastrous floods. The average annual temperature in the lowest parts is 52.5 degrees, varying from 32.5 degrees in winter to 71.5 degrees in summer. It is seldom that the temperature rises above 92 and a temperature of 22 degrees below zero is the lowest that has ever been recorded.

The following statistics concerning temperature, precipitation, and snowfall at Upper Tract and Brandywine, furnished by H. C. Howe, Meteorologist, United States Weather Bureau, Parkersburg, West Virginia, give the main climatological facts for the county:

Precipitation: Monthly and Annual, Brandywine, W. Va.

(Elevation, 1586 feet.)

(Record made by Mr. Elmer L. Keister, Brandywine, W. Va.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1916	....	....	....	....	....	2.50	3.45	1.90	4.60	1.04	0.78	1.41	......
1917	1.82	2.50	6.01	2.08	2.90	1.38	2.49	2.16	2.16	3.31	0.29	0.81	27.91
1918	3.94	1.07	3.77	5.18	3.69	5.44	4.20	3.66	3.87	2.40	1.17	2.70	41.09
1919	2.62	0.95	2.49	1.87	3.94	3.45	5.47	2.77	0.75	2.46	1.18	1.47	29.42
1920	2.05	2.63	2.70	3.33	1.59	4.10	3.50	5.97	1.90	0.45	3.15	2.10	33.47
1921	1.00	1.10	1.25	1.85	2.80	1.30	2.85	2.50	3.05	1.15	3.90	2.07	24.82
1922	1.58	9.60	3.20	1.40	3.75	2.75	3.20	2.95	0.65	2.40	0.45	2.60	28.53
1923	2.55	0.90	2.10	2.35	1.50	2.20	3.20	1.95	3.55	0.85	2.20	1.50	24.85
1924	2.90	1.20	3.05	2.35	5.75	5.60	3.65	3.25	4.30	0.75	1.95	1.40	36.15
1925	3.65	0.75	3.10	3.60	1.40	3.90	2.90	1.70	1.50	3.45	1.90	....	......
Means	2.46	1.63	3.07	2.67	3.03	3.27	3.49	2.88	2.63	1.83	1.70	....	27.36

Precipitation, Upper Tract, W. Va.

(Elevation, 1494 feet.)

(Record made by Mr. J. M. Mallow, Upper Tract, W. Va.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1897	....	....	....	....	....	....	....	....	0.09	0.93	....	2.05	......
1898	3.26	0.64	3.36	3.16	4.20	2.09	4.23	8.83	1.15	5.82	2.16	1.99	40.89
1899	2.28	4.21	2.40	0.94	3.75	4.04	1.89	3.76	4.68	1.36	1.95	1.60	32.86
1900	1.50	2.78	3.46	0.75	3.60	4.17	2.68	2.48	2.85	2.60	4.42	1.82	33.11
1901	1.58	0.33	2.53	6.55	5.46	4.82	3.48	6.19	2.49	0.18	1.55	5.30	40.46
1902	2.28	3.50	3.68	2.35	2.23	3.81	2.07	2.87	2.37	2.21	3.19	3.14	33.70
1903	2.62	2.48	2.96	2.29	3.34	6.02	2.37	4.82	2.52	1.80	0.67	0.51	32.40
1904	1.70	1.42	1.95	2.31	3.63	3.98	6.00	1.75	1.24	1.14	0.77	2.51	28.40
1905	2.94	1.63	2.29	1.25	4.45	6.30	5.91	5.18	0.73	3.02	1.03	4.25	38.98
1906	2.36	0.65	3.45	2.85	1.52	4.02	4.17	7.03	2.02	3.90	1.02	2.95	35.94
1907	2.51	1.04	2.52	1.42	2.57	7.12	4.87	2.82	5.40	1.01	2.35	3.69	37.32
1908	3.44	2.85	2.26	0.77	7.48	3.00	5.35	3.75	1.21	1.51	1,10	1.96	34.68
1909	1.96	1.44	1.11	4.54	3.35	6.62	1.00	1.59	1.74	2.52	0.84	2.35	29.06
1910	4.66	2.46	0.27	2.37	1.79	8.36	3.08	1.16	1.38	1.72	0.85	1.03	29.13
1911	5.14	1.07	2.44	2.84	1.89	3.16	3.72	8.36	2.39	3.80	1.51	1.61	37.93
1912	1.10	0.72	1.78	1.09	3.76	2.25	6.80	0.68	4.50	0.50	0.95	1.57	25.70
1913	2.35	0.21	4.21	4.06	4.98	3.02	3.50	2.83	3.39	4.52	2.91	1.35	37.33
1914	1.95	2.21	1.62	2.30	0.55	2.90	4.57	1.38	1.22	2.49	1.72	4.51	27.42
1915	3.61	0.90	0.55	0.10	3.12	2.95	1.82	6.22	2.17	3.05	1.52	1.35	27.36
1916	2.40	2.18	2.83	2.56	1.05	3.73	3.77	1.81	2.80	1.50	0.75	0.85	26.23
1917	1.72	2.20	4.75	2.21	3.23	1.60	5.53	2.30	2.63	2.60	0.05	1.30	30.12
1918	4.40	1.65	3.40	6.30	2.43	4.30	3.45	2.40	2.93	1.70	1.30	2.70	36.86
1919	1.60	0.35	2.25	1.70	3.43	3.90	4.50	0.95	1.20	2.90	0.85	1.31	24.94
1920	1.30	1.85	2.30	2.16	1.35	4.40	2.75	7.00	2.65	0.10	1.77	1.36	28.99
1921	0.10	1.42	0.70	0.40	4.20	1.60	4.38	2.13	1.65	0.30	3.12	1.16	21.16
1922	1.39	2.03	1.40	0.60	1.55	1.75	4.35	2.43	0.10	2.35	0.20	1.16	19.21
1923	1.13	0.75	0.88	1.00	0.48	1.25	....	1.60	4.30	1.05	3.25	1.00	......
1924	2.10	0.84	3.20	0.72	5.60	1.90	2.20	1.60	3.95	0.15	0.45	0.58	23.29
1925	2.44	0.35	1.70	....	0.70	1.05	3.10	0.30	....	2.19	0.65	....	......
Means	2.35	1.58	2.38	2.20	3.05	3.72	3.76	3.36	2.35	2.03	1.53	2.03	30.34

Snowfall, Monthly, Upper Tract, W. Va.

(Record made by Mr. J. M. Mallow, Upper Tract, W. Va.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	Oct.	Nov.	Dec.	Annual.
1897	......	......	......	......	......	......	0.2	2.5	....
1898	1.2	T	2.0	2.5	......	......	4.0	6.5	16.2
1899	10.5	29.2	T	......	......	......	T	6.0	45.7
1900	T	12.0	14.0	......	......	......	1.0	2.1	29.1
1901	2.0	......	0	4.6	......	......	7.1	3.0	....
1902	11.0	5.8	22.5	6.4	......	......	......	6.0	51.7
1903	6.0	8.6	3.0	T	......	......	......	1.5	....
1904	4.2	10.8	......	0.5	......	......	1.0	7.0	....
1905	23.5	......	3.0	2.0	......	T	2.0	13.6	....
1906	4.0	6.5	10.8	T	T	T	T	......	....
1907	4.0	8.8	1.0	1.5	......	......	T	5.2	20.5
1908	15.0	14.0	T	......	......	......	11.0	11.0	51.0
1909	3.0	4.0	3.5	T	......	......	T	4.5	15.0
1910	10.0	14.0	1.0	......	......	0.5	T	10.0	35.5
1911	3.0	2.5	5.0	......	......	......	......	......	....
1912	5.0	......	3.0	......	......	......	......	7.0	....
1913	......	......	......	......	......	......	3.0	4.0	....
1914	15.0	12.0	......	......	......	......	......	8.5	....
1915	10.0	......	1.2	......	......	......	......	......	....
1916	7.0	10.0	3.0	3.0	......	......	......	10.5	33.5
1917	......	6.5	......	......	......	......	......	13.0	....
1918	......	......	......	21.0	......	......	......	T	....
1919	10.0	......	T	......	......	......	......	4.0	....
1920	......	12.6	......	T	......	T	7.5	......	....
1921	......	9.0	......	......	......	......	......	4.0	....
1922	15.0	12.0	......	......	......	......	......	2.0	29.0
1923	7.0	......	6.0	......	T	......	......	......	....
1924	2.0	8.0	10.0	4.0	......	......	......	6.0	30.0
1925	29.0	......	......	......	......	3.0	......	......	....
Means	8.6	9.8	3.9	1.8	T	0.1	1.4	6.0	31.6

Note: T=Trace.

Snowfall, Monthly and Annual, Brandywine, W. Va.

(Elevation, 1586 feet.)

(Record made by Mr. Elmer L. Keister, Brandywine, W. Va.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	Oct.	Nov.	Dec.	Annual.
1916	......	......	......	......	......	0	0	8.0	....
1917	3.3	9.0	11.0	T	......	4.0	T	10.5	37.8
1918	18.8	2.0	0	7.0	......	0	0	T	27.8
1919	7.0	5.0	0	0	......	0	0	5.0	17.0
1920	1.0	15.0	T	3.0	......	T	5.0	0	24.0
1921	3.0	9.5	0	0	......	0	0	8.0	20.5
1922	12.0	11.0	0	0	......	0	T	2.0	25.0
1923	11.0	2.5	4.0	0	T	0	T	1.0	18.5
1924	2.0	6.0	19.0	4.0	......	0	1.0	T	32.0
1925	30.0	T	T	0	......	8.0	T	......	....
Means	9.8	6.7	3.8	1.6	......	1.2	0.6	3.4	25.3

Average Temperature, Monthly, Upper Tract, W. Va.

(Elevation, 1494 feet).

(Record made by Mr. J. M. Mallow, Upper Tract, W. Va.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1897	....	....	....	....	....	....	....	....	72.2	63.4	46.0	....	......
1898	38.2	34.0	49.0	46.4	64.3	70.2	74.9	74.2	67.4	55.2	42.4	33.0	54.1
1899	33.2	27.2	43.4	52.7	64.1	71.2	74.2	73.0	64.7	56.0	44.8	34.3	53.3
1900	34.5	31.0	38.8	51.0	62.0	70.1	74.0	75.8	71.2	59.0	46.2	36.1	54.2
1901	34.8	28.7	42.6	46.9	60.8	....	76.0	72.0	63.2	54.6	38.0	32.6	......
1902	31.0	25.8	42.9	49.4	63.6	66.8	71.8	69.6	64.2	56.0	50.3	35.2	52.2
1903	31.4	36.5	50.3	51.4	62.2	63.6	72.2	70.5	64.8	55.4	39.6	29.1	52.2
1904	29.0	28.8	43.1	47.3	61.0	68.8	71.1	69.8	66.9	54.0	40.5	32.6	51.1
1905	27.8	25.9	45.8	52.2	64.0	69.0	72.6	70.6	64.7	53.7	42.5	35.1	52.0
1906	37.8	33.5	36.4	54.0	61.4	69.9	71.2	73.6	68.5	52.2	44.8	37.4	53.4
1907	37.8	30.6	48.0	46.1	58.7	63.2	71.8	68.4	65.8	49.6	42.2	35.6	51.5
1908	31.4	29.0	48.0	55.0	61.5	67.7	72.4	69.2	64.1	54.1	45.4	36.8	52.9
1909	37.2	42.6	41.2	53.4	59.9	70.6	69.1	69.6	63.4	50.1	49.4	29.4	53.0
1910	34.2	34.1	50.2	54.7	58.2	65.8	72.2	70.2	67.7	57.8	38.0	27.6	52.6
1911	39.0	37.8	41.0	48.6	64.2	68.8	72.4	72.5	68.0	55.3	40.5	38.8	53.9
1912	24.4	28.7	39.6	56.7	62.2	66.4	71.6	68.6	69.2	55.4	45.2	37.5	52.1
1913	42.4	35.0	46.6	52.8	61.4	67.8	72.6	70.2	62.2	54.4	46.0	37.6	54.1
1914	36.6	30.1	37.7	52.3	62.1	71.2	71.2	71.0	62.4	55.5	43.3	29.2	51.9
1915	31.0	37.8	33.7	54.6	59.6	65.6	71.2	68.4	66.0	57.0	44.7	31.5	51.8
1916	40.8	33.4	37.5	50.3	63.2	63.4	72.9	71.8	....	54.2	46.2	33.8	......
1917	33.3	32.8	41.8	54.1	57.1	68.4	72.6	71.3	62.2	51.2	42.6	22.3	50.8
1918	20.0	36.2	47.0	48.6	65.6	66.4	67.3	74.0	58.9	57.5	43.0	39.8	52.0
1919	34.6	33.6	44.6	51.5	60.4	70.8	71.0	68.0	64.7	63.3	44.0	30.2	53.1
1920	26.3	30.4	37.6	43.8	54.7	....	69.0	69.2	64.6	56.1	41.8	34.8	......
1921	32.6	35.4	51.0	52.8	57.6	69.4	73.3	68.4	70.1	53.8	45.0	37.8	53.9
1922	29.4	37.8	43.1	53.9	62.1	69.6	71.7	64.8	65.4	56.8	45.2	33.6	52.8
1923	31.8	27.6	42.8	48.6	55.5	69.2	68.8	68.3	63.0	49.1	39.2	42.4	59.5
1924	27.4	28.1	37.4	47.8	51.7	65.6	65.8	68.2	57.4	48.9	40.6	29.8	47.4
1925	26.6	37.6	40.2	....	54.4	68.0	65.8	65.7	....	49.4	38.6	....	......
Means	32.7	32.5	42.9	51.0	60.5	68.0	71.5	70.3	65.3	54.8	43.3	33.8	52.5

Mean Temperature, Monthly, Brandywine, W. Va.

(Elevation, 1586 feet.)

(Record made by Mr. Elmer L. Keister, Brandywine, W. Va.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1916	....	....	....	....	....	....	73.0	71.0	62.0	53.6	43.6	32.6	......
1917	34.5	32.6	41.4	51.3	55.4	66.6	72.1	70.6	61.4	48.8	38.9	22.7	49.7
1918	20.4	35.2	46.4	49.0	65.0	65.8	67.7	73.1	58.8	56.8	43.2	40.1	51.8
1919	34.2	35.4	44.6	51.9	60.2	69.9	72.4	68.4	64.0	63.2	43.8	31.7	53.3
1920	31.1	30.9	42.4	50.0	56.0	66.0	68.8	70.5	64.6	55.9	40.2	34.3	50.9
1921	34.9	36.3	51.6	54.7	58.8	70.1	73.7	68.0	69.8	52.8	46.0	36.2	54.4
1922	27.8	39.0	44.7	52.7	62.5	70.1	72.2	68.8	65.6	54.4	43.6	39.0	53.4
1923	34.0	30.8	42.6	48.8	57.9	69.6	71.2	71.0	65.6	50.3	40.0	41.2	51.9
1924	28.7	29.1	36.3	46.0	52.2	66.2	67.8	69.2	58.2	50.1	42.0	32.2	48.2
1925	25.2	37.1	40.6	....	55.2	71.1	70.4	68.6	69.8	48.0	38.8	....	......
Means	30.1	34.0	43.4	50.6	58.1	68.4	70.9	69.9	64.0	53.4	42.0	34.4	51.6

National Forests.—Pendleton County lies, roughly, near the center of the National Forest areas. Because of its rugged topography a large part of the county is naturally adapted to

forests, and is being rapidly acquired by the Forest Service as forest preserves. Before the recent acquisition of the Seneca-Smoke Hole extension area the Monongahela National Forest purchase area included the land lying west of the North Fork River to the Randolph County line. The Shenandoah National Forest area included the land lying east of the South Fork River to the Virginia State line.

In the Monongahela National Forest area, which includes about 212,000 acres, 28,223 acres in Pendleton County had been acquired to July 1st, 1927.

In the Shenandoah National Forest area, which includes about 750,000 acres of which 52,000 acres lie in West Virginia and the remainder in Virginia, 22,596 acres in Pendleton County of a total of 23,333 approved for purchase have been acquired to July 1st, 1927.

Seneca-Smoke Hole Extension Area.—According to C. L. Perkins, Forest Supervisor, this extension includes a gross area of 84,000 acres, 27,000 of which lies in Grant County and 57,000 in Pendleton County. About 72,000 acres of this land is classified as pure forest land, the remainder of which is better adapted to agriculture or grazing and the Government will make no effort to acquire it.

It is the policy of the Forest Service to make road and trail improvements in and around all National Forest land as needs justify and funds will permit.

The following map, prepared by Paul H. Price, gives the locations of the respective areas within the limits of Pendleton County:

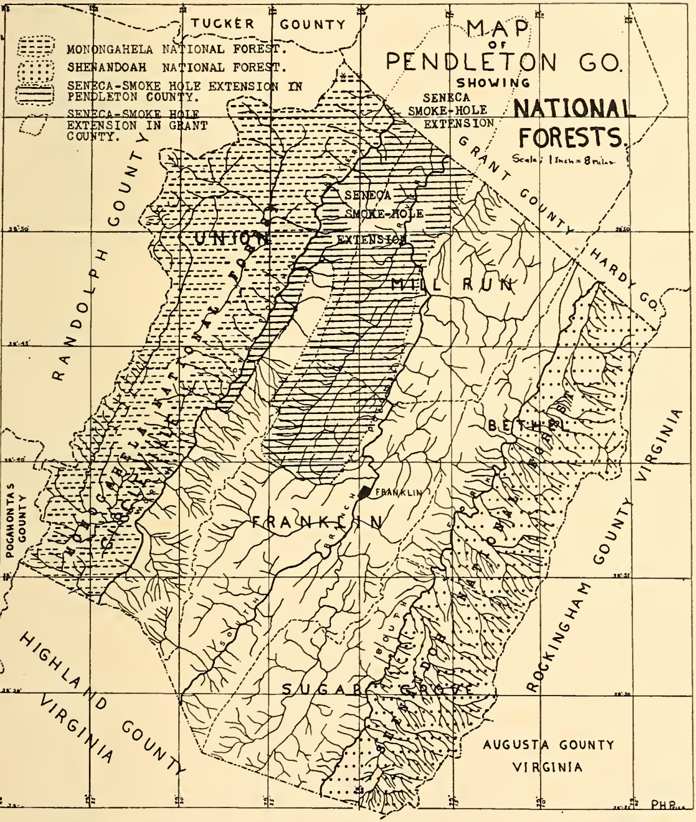

Figure 3.—Map of Pendleton County showing National Forests.

Population.—The following table, taken from the United States Census returns for 1920, shows the population of Pendleton County for the last three Census years:

Population of Pendleton County.

Minor Civil Division.	1920	1910	1900
Bethel District	1,161	1,149	1,121
Circleville District	1,537	1,521	1,491
Franklin District, including Franklin town	1,863	1,701	1,605
Mill Run District	1,581	1,646	1,651
Sugar Grove District	1,606	1,478	1,434
Union District	1,904	1,854	1,865
Totals	9,652	9,349	9,167

The following table shows the number of inhabitants in Pendleton County per square mile, and the percentage of increase in population since 1890:

Area Sq. Mi.	1920		1910	1900	1890	1880	1870
	Total	Per Sq. Mi.					
696.9	9,652	13.8	9,349	9,167	8,711	8,022	6,455

Per cent. of increase.

1910 to 1920	1900 to 1910	1890 to 1900
3.2	2.0	5.2

The above table shows that Pendleton County with 13.8 has the smallest number of inhabitants per square mile of any county in the State, while its bordering county to the southwest, Pocahontas, has an average of 16.6 inhabitants per square mile. Hardy County to the northeast is little better off with 16.7, while Hampshire has only 18.1. Several reasons for this

condition might be given, the chief of which are the large areas of mountainous land that can not be used for cultivation, the lack of transportation facilities, and the absence of public works.

Franklin, the county-seat, and the largest town in the county, had a population of 320 in 1920.

Products.—The latest official information regarding the number of farms and their products with their relative importance is the 14th Census of the United States, Volume VI, taken in 1920. From it the following data were taken:

Land area[1]..446,000 acres.

Land in farms:	Acres.	Improved land in farms:	Acres.
1920	280,064	1920	110,928
1910	312,694	1910	88,146
1900	343,330	1900	115,691

Stock:		Grain:	Bushels.
Sheep	29,363	Corn	290,025
Cattle: Beef	11,498	Wheat	89,205
Cattle: Dairy	3,475	Oats	29,910
Swine	7,922	Rye	14,853
Horses	3,470	Buckwheat	9,518
Burros	100	Barley	491
Goats	47		
Mules	19		

It can be seen from the first table that the number of acres in farming land has decreased 63,226 between the years 1900 and 1920. In the year 1920 the farms averaged 332.3 acres. 62.8 per cent. of the area of the county is in farms.

As can be seen from the table, sheep, cattle, swine, and horses are the principal stock, while corn, wheat, oats, and rye are the principal grains.

Property Valuation.—The following table showing the property vaulation of Pendleton County for the years 1923, 1924, and 1925, was furnished by the County Clerk at Franklin, E. W. Dolly:

[1]Note: The area and farm percentages were computed by Paul H. Price on the basis of the area of the county given in this Report on page 10.

	1923	1924	1925
Real Estate	$4,302,055	$4,291,760	$4,225,439
Personal Property	1,876,700	1,691,338	1,761,210
Public Utilities	7,286	4,710	4,600
Totals	$6,185,041	$5,987,808	$5,991,249

District.	1923 Personal Property.	1923 Real Estate.	1924 Personal Property.	1924 Real Estate.	1925 Personal Property.	1925 Real Estate.
Bethel	$ 194,905	$ 598,055	$ 176,490	$ 595,725	$ 186,370	$ 593,859
Circleville	339,980	652,265	302,665	654,540	291,230	611,620
Franklin	492,550	921,300	453,663	914,820	497,890	925,180
Mill Run	306,800	739,165	289,945	739,485	287,610	730,885
Sugar Grove	246,245	623,990	205,075	619,740	215,365	618,575
Union	296,220	767,280	263,500	767,450	282,745	745,320
Totals	$1,876,700	$4,302,055	$1,691,338	$4,291,760	$1,761,210	$4,225,439

1926 Assessments.

The following figures showing the 1926 assessments of real estate and personal property in Pendleton County have been furnished by E. W. Dolly, Clerk of the County Court, and H. M. Calhoun, Attorney, of Franklin, West Virginia. Public utility assessments were not submitted but it is assumed they will approximate the figures for 1925:

District.	Real Estate.	Personal Property.	Total.
Bethel	$ 558,060	$ 159,835	$ 717,895
Circleville	599,150	295,825	894,975
Franklin District	725,685	204,335	930,020
Franklin Town	200,735	265,185	465,920
Total Franklin District	926,420	469,520	1,395,940
Mill Run	723,670	261,500	985,170
Sugar Grove	618,410	215,705	834,115
Union	742,090	262,020	1,004,110
Totals, County	$4,167,800	$1,664,405	$5,832,205

Postal Service.—Pendleton County having no railroads is dependent entirely upon the star-route system. Daily mail comes into the county from Petersburg, Grant County, Harman, Randolph County, and Harrisonburg, Virginia. The fol-

lowing list of post-offices with their mail service was furnished by Mr. Wilbur Dolly, Postmaster at Franklin:

Post-office.	District.
Branch	Mill Run.
Brandywine*	Bethel.
Brood	Union.
Brushy Run	Mill Run.
Cave*	Franklin.
Circleville*	Circleville.
Creek	Mill Run.
Dahmer	Franklin.
Deerrun	Mill Run.
Dryrun	Circleville.
Fame	Bethel.
Fort Seybert*	Bethel.
Franklin*	Franklin.
Hunting Ground	Circleville.
Key*	Union.
Kline*	Mill Run.
Macksville*	Union.
Mitchell	Sugar Grove.
Mouth of Seneca*	Union.
Moyers	Sugar Grove.
Mozer	Mill Run.
Onego*	Union.
Rexrode	Franklin.
Riverton*	Union.
Roaring	Union.
Ruddle*	Franklin.
Simoda	Union.
Sugar Grove*	Sugar Grove.
Teterton	Union.
Upper Tract*	Mill Run.
Zigler	Franklin.

Note: Offices having a daily mail are marked (*). Offices that issue money orders are in bold face type.

PLATE II.—A view of Franklin looking north. The even-crested sky-line represents the Harrisburg Peneplain. (See Plate V for view of Franklin looking south). (Photo. by Paul H. Price).

TOWNS AND INDUSTRIES.

It is seldom that any area is doubly blessed with both natural resources and scenic beauty. Pendleton County is no exception. It lies outside our State's great deposits of coal, oil, and gas, but is richly endowed with wonderful scenery and fine climate, a condition that must be realized by the citizens of the county and developed accordingly. Consequently there are no large cities or industries within the limits of the county. Heretofore the largest enterprises have been lumber and agriculture. A large part of the timber has now been cut over and as the land is not particularly adapted to farming other enterprises will have to be inaugurated. Since natural beauty is one of the county's big assets it would be well to plan along that line.

Franklin, the county-seat, is the largest town with a population of about 400.

The following list of towns gives the estimated population for 1926 by Wilbur Dolly, Postmaster at Franklin:

Brandywine	75
Brushy Run	25
Circleville	75
Fort Seybert	50
Franklin	400
Mouth of Seneca	25
Oak Flat	10
Onego	75
Riverton	75
Ruddle	25
Sugar Grove	75
Upper Tract	50

The following poem by H. M. Calhoun has been submitted to the Survey for inclusion in the volume:

PENDLETON, MY PENDLETON.

H. M. Calhoun.

Air: "Maryland, My Maryland".

There is no better place to dwell,
Pendleton, my Pendleton;
No other land we love so well,
Pendleton, my Pendleton;
With lovely vales all mountain bound,
With Eden's beauty scattered 'round,
No fairer spot was ever found,
Pendleton, my Pendleton.

Here stand your mountains tall and fine,
Pendleton, my Pendleton;
In beauty clad with oak and pine,
Pendleton, my Pendleton;
The unfettered eagle wings his flight,
About their summits bathed in light,
All circled 'round by stars at night,
Pendleton, my Pendleton.

And here are valleys fertile, fair,
Pendleton, my Pendleton;
Smiling in beauty everywhere,
Pendleton, my Pendleton;
Transparent rivers, streams, and rills,
All undefiled by mines or mills,
Flow through them from your stately hills,
Pendleton, my Pendleton.

Here dwell a people true and good,
Pendleton, my Pendleton;
Purest of Anglo-Saxon blood,
Pendleton, my Pendleton;
Free from foul immigration's tide,
From turmoil and from strife aside,
In peace and plenty here abide,
Pendleton, my Pendleton.

May God bestow on you His care,
Pendleton, my Pendleton;
Shield your brave sons and daughters fair,
Pendleton, my Pendleton;
And wheresoe'er their feet may stray,
In thought and dream both night and day,
May they remain with you alway,
Pendleton, my Pendleton.

CHAPTER II.

PHYSIOGRAPHY AND WATER-POWER.

INTRODUCTION.

In the area under discussion the rocks are, with two exceptions, of sedimentary origin. The two exceptions are two small igneous dikes, located in the south center of the county and of minor importance to its physiography. These sediments were subjected to great pressure resulting in numerous folds and some faulting. In the extreme western part of the county the folds become more open and continue to decrease to the west. The western border of the county follows the crest of Allegheny Mountain. During Cretaceous or Jura-Cretaceous time the area was more or less perfectly peneplaned and later uplifted with some warping. This peneplain was again leveled in the less resistant areas and maturely dissected in the hard rock or more resistant areas. This peneplain is known as the Harrisburg or Tertiary Peneplain. The whole has been uplifted again and further dissection is now going on. In some of the adjoining counties intermediate peneplanation has been noted, but because of the maturity of dissection in this area definite correlations could not be made.

The Paleozoic rocks in the area range in age from Ordovician to Carboniferous. The lowest member is the Shenandoah Limestone, but its complete thickness is not exposed, the outcrop being limited to a small area between River Knobs and North Fork Mountain. Because of its soluble character it is a valley maker. Immediately over these limestones is the still less resistant Martinsburg Shale. This formation attains a thickness of 2250$\pm$ feet and is also a valley maker. The resistant Medina Sandstones (Gray, Red, and White) overlie the Martinsburg Shale with a thickness of 500 to 600 feet. These

are all prominent mountain makers as evidenced by River Knobs, North Fork Mountain, Peters Mountain, Jack Mountain, and others. Following the Medinas the Rockwood Formation of the Clinton Series is a resistant quartzite making less prominent ridges along the flanks of the Medina. The Silurian Limestones because of their soluble character are generally valley makers unless protected by the overlying Oriskany Sandstone. In the area under discussion the Oriskany Sandstone is one of the most prominent outcropping rocks, and is also a very common ridge and mountain maker. The overlying shales—Marcellus, Hamilton, and Genesee—because of their weak character are now found only in the synclinal valleys or other protected places. The remaining Devonian Shales—Portage, Chemung, Catskill—have an increasing amount of sandstone and hence are more resistant. The Shenandoah Mountain marking the eastern border of the county is made up of them, being capped at a few points by the Pocono Sandstones. The Greenbrier Limestone (350′-450′ thick) is a valley maker where it is not covered, while the overlying Mauch Chunk Shales and Sandstones (1,500′-2,000′ thick) make steep slopes with intermediate benches. The high plateau region, particularly Roaring Plains, is capped by the resistant Pottsville Conglomerate. It can be readily seen that the important ridge and mountain makers are the Medinas, Rockwood Quartzite, Oriskany Sandstone, Catskill-Chemung Sandstones, Pocono Sandstones, and Pottsville Conglomerate.

The Allegheny Front which is marked by an escarpment 1,500 to 3,000 feet high marks the western border of the county and separates the Physiographic provinces, Appalachian Plateau on the northwest from the Appalachian Valley on the southeast. These provinces extend northeast-southwest or in conformity to the folds of the rocks. The general strike of the region is approximately N. 30° E.

THE RESTORED SURFACE.

Because of the maturity of the dissection, definite recognition of the peneplain level is often difficult. It is doubtful

if there is any topographic feature that dates earlier than the Schooley Peneplain and its monadnocks.

When so vast an area (as represented by this peneplain) is uplifted some warping is bound to occur. This feature is well brought out by Wright[1]. The courses of the major streams in the immediate area were determined largely by the warping. Since several major streams, Potomac River, James River, Greenbrier River, and Cheat River, head near the southern and southwestern limits of the area under discussion, it is obvious that this region was near the maximum elevation of the Schooley Peneplain.

This uplifted surface has been largely destroyed by streams that have cut deep valleys below it. There is probably no other county in the State that presents as much close folding as this area. Hence it is very difficult to determine with certainty the true relationship of this peneplain, particularly in the center of the county.

In order to bring out more clearly this old level 13 projected profiles were drawn at right angles to the general strike of the region. On each profile the maximum elevation between it and the next profile was plotted. After the profiles were plotted they were cut from cardboard and set up in their proper position, thus giving at a glance the physiographic features of the entire county. The model used is seen on Plate III.

THE SCHOOLEY PENEPLAIN.

An examination of the profiles reveals three important levels. The upper peneplain or Schooley, the Harrisburg Peneplain, sometimes called Valley or Tertiary, and the present major stream levels. The Schooley is still well represented in the western, southern, and eastern limits of the county, with apparently no local remnants in the east central portion. These present elevated regions represent the maximum uplift

[1]Wright, Frank J.: The Physiography of the Upper James River Basin, Bull. No. XI, Virginia Geological Survey, 1925.

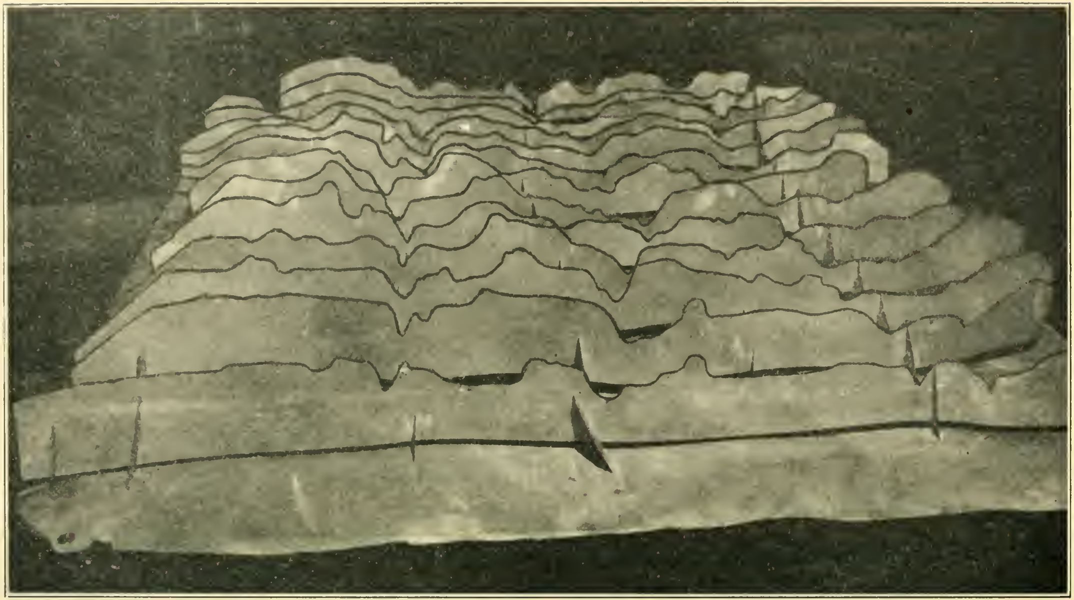

PLATE III.—Profile model showing physiographic features of county. (Model by Paul H. Price and photo. by E. E. Harris).

at the close of Jura-Cretaceous time as evidenced by the present major streams flowing north, east, south, and west from them. The zone of maximum uplift seems to trend with the folds along the Allegheny escarpment and descend to the northwest, north, and southeast. The Schooley Peneplain is represented in Pendleton County by the crests of many ridges and on the west by the broad Allegheny Mountains, with elevations from 4,000 to 4,700 feet. In Gilmer County it descends to 1,400 feet, in Summers County to approximately 3,000 feet, and on Patterson Creek Mountain at the Mineral-Hampshire-Hardy County line to 2,750 feet. The Schooley Peneplain is well above and entirely distinct from the Harrisburg Peneplain which is itself dissected by streams to depths of 400 to 500 feet. Therefore the topography now reveals five distinct features: (1) Monadnocks on the Schooley Peneplain, (2) Remnants of the Schooley Peneplain, (3) Monadnocks on the Harrisburg or Tertiary Peneplain, (4) the Harrisburg Peneplain, (5) Valleys cut below the Harrisburg Peneplain.

The Schooley Peneplain has been correlated with the same peneplain in New Jersey where it was named by Prof. W. M. Davis. It is now generally regarded as Jura-Cretaceous in age. In the present area no data were available to help in determining its age, hence the correlation in adjoining areas was accepted. If, however, Stose's[2] contention be true, that is, that the Kittatinny and the Schooley are the same, and that the difference in level is due to faulting, some later revision will be necessary. This problem, however, is one to be determined in those areas, and until such time as that contention is proved the present correlations will be used.

Monadnocks on the Schooley Peneplain.

It would be hard to realize complete base-leveling over so great an area as the Schooley Peneplain extends, especially in the complexly folded areas where there is such difference in the resistancy of the rocks. From the remaining areas that seem to stand above the general level of the old peneplain it is

[2]Stose, G. W., Abstract from paper delivered at the 1926 meeting of the Geological Society of America.

PLATE IV.—A view east from Oak Flat. The lower line of ridges marks the Harrisburg Peneplain while the Shenandoah Mountain in the background marks the Schooley Peneplain. (Photo. by Paul H. Price).

concluded that these areas were not completely removed to sea-level. These monadnocks would owe their existence to their greater resistancy or to their distance from the main drainage basins. In the present monadnocks both causes seem to have had their influence as they are capped by the resistant Pottsville Conglomerate and are possibly at the maximum distance from the main drainage lines. Within the limits of Pendleton County the areas not completely base-leveled seem to be limited to the western side of the county. Some points along Roaring Plains that now stand higher than 4,700 feet are considered above the level of the Schooley Peneplain. Spruce Mountain also remained above the general level of the Schooley. In the northern corner of Augusta County, Virginia, and very near the Pendleton County line, Bald Knob stands approximately 400 feet above this peneplain.

Remnants of the Schooley Peneplain.

The best remnant of the Schooley Peneplain is the summit of the Allegheny Mountain marking the western boundary of the county. Along this mountain which marks the "Allegheny Front", in the northwest part of the county the rock that caps this peneplain is the Pottsville Conglomerate with an approximate level of 4,600 feet, while continuing southwest along the same ridge the Catskill-Chemung Series marks the surface. The mountain in general has a slight western dip with the edges beveled by the erosion surface, thus illustrating its true peneplain character. This mountain varies in elevation along the western border of the county from 4,000 to 4,600 feet, with some points in the Roaring Plains region rising above 4,700 feet. The latter, however, represent monadnocks.

Spruce Mountain.—With the general level of the Schooley Peneplain at 4,400 to 4,600 feet in the vicinity of Spruce Mountain the ridges rising above this latter level would seem to represent monadnocks.

North Fork Mountain.—In the southern limits of the county North Fork Mountain still presents remnants of the Schooley Peneplain. Panther Knob, 4,490 feet, Kile Knob,

4,366 feet, Goshen Ridge, 4,337 feet, and probably Harmon Roeks, 4,054 feet, are remnants of this peneplain.

Shenandoah Mountain.—The synelinal Shenandoah Mountain marks an important drainage divide, also a barrrier to the movement of population and henee was a natural divide between the two Virginias. Although maturely disseeted it is highly probable that several of its highest elevations are remnants of the Sehooley Peneplain, partieularly those standing above 4,000 feet.

HARRISBURG PENEPLAIN.

As stated earlier in this diseussion, definite reeognition of the Harrisburg or Tertiary Peneplain is made more uneertain than the Sehooley Peneplain beeause of the eomplexity of the folds, thus bringing the resistant roeks in the summits and weaker roeks in the basins, along with the maturity of disseetion. In this peneplain, eomplete base-leveling did not take plaee as it did in the former. It is only in the areas of less resistant roeks that anything like a peneplain was reaehed. Limestones and shales show mueh beveling while the sandstones and quartzites stand as ridges. Sinee these latter roeks outerop so often in the numerous valley folds the Harrisburg Peneplain is only slightly developed and has sinee been largely disseeted by stream valleys cut below it.

It is a notieeable faet that where the Sehooley Peneplain is best developed the Harrisburg Peneplain is poorly represented and viee versa. Henee the best development of the Harrisburg Peneplain would be expeeted in the east eentral part of the eounty or along the South Braneh and South Fork Rivers.

This peneplain is represented in Pendleton County by erosional surfaees that stand between 2,500 and 3,000 feet. Along the North Fork of the Potomae River there is a line of levels represented by a eomparatively narrow beneh, averaging 2,800 feet in elevation, that seems to represent this peneplain. Between North Fork Mountain and the South Fork of the Potomac River there is a eomparatively even sky-line represented by the axes of numerous folds with cap roeks ranging in age from the Oriskany Sandstone to the White

PLATE V.—View of Franklin looking south. The even-crested sky-line marks the dissected Harrisburg Peneplain. (Photo. by Paul H. Price).

Medina quartzite. The average elevation of these ridges, which are its local representatives, is 3,000 feet or the general level of the Harrisburg Peneplain.

In the eastern part of the county this peneplain is still preserved between the South Fork of the Potomac River and Shenandoah Mountain by a continuous row of knobs standing at an average height of 2,800 feet.

It is true that there are many points between the North Fork and the South Fork of the Potomac River where resistant sandstone or quartzite stands above 3,000 feet but these are monadnocks standing on the Harrisburg Peneplain.

RIVER TERRACES.

The river terraces are none too well represented in Pendleton County, particularly along the North Fork and South Branch of the Potomac River. This is due to the unfavorable condition for the preservation of terrace deposits. In most places in the county these streams have cut deep gorges through the resistant strata and removed most of the non-resistant shales from their valleys. The terraces are best developed along the South Fork of the Potomac River in the longitudinal shale valley.

There are three distinct terraces above the flood-plain (See Plate LXIII) with apparently no definite interval separating them at different points along these streams. The lower level or flood-plain varies from 5 to 10 feet above the normal level of the stream. The first terrace is found from 15 to 25 feet above the flood-plain while the interval between this terrace and the second or next terrace above is approximately 30 feet. (See Plate LXII). From the second terrace to the third terrace the interval varies also, sometimes being less than that from the first to the second, but generally greater. It is known to vary from 50 feet to as much as 120 feet. Along the South Fork of the Potomac River the interval is usually 90 feet. Along the North Fork, however, the third terrace is well developed just north of the road forks at the Mouth of Seneca at an elevation of 1,760 feet or 250 feet above the river, while one-half mile south of this place the second terrace

PLATE VI.—"Reunion Grounds". Here the flood-plain of Thorn Creek makes an inviting place for campers. (Photo. by Paul H. Price).

PLATE VII.—View from County Farm looking north across the flood-plain and terraces of the South Branch. Upper Tract can be seen in the extreme left. (Photo. by Paul H. Price).

is shown at an elevation of 1,660 or an interval of 100 feet between the two. It can thus be readily seen that no definite interval can be established between them. (See Plate VIII for terraces and flood-plain at Mouth of Seneca).

The terraces in the area under consideration seem to be largely if not entirely of the "Rock-defended rock terraces" described by Wright[2]. These terraces are formed in non-resistant rocks, like shale, which contain a resistant member that causes the stream to deflect and leaves terraces of the non-resistant material. It is a significant feature that most all of the remaining terraces in this area occur upon the non-resistant Hamilton-Marcellus Shales. The surfaces of the terraces are usually quite flat but often rise from front to back. (See Plate LXII). This latter condition could be caused in part at least by later erosion.

Large gravel and boulders are found on most of these terraces. (See Plate LXI). Franklin, the county-seat, is located upon a second terrace with an average elevation of 1,730 feet. These boulders were uncovered in the excavation for the new Court-House. These were deposited upon the rolling Oriskany Sandstone and Marcellus Shale remaining in protected basins. Mouth of Seneca is located upon the first terrace with an elevation of 1,570 feet, while Upper Tract is built upon the terrace with an elevation of 1,560 feet. Mount Olive School is located upon a well-exposed boulder and gravel bed with an elevation of 2,030 feet. This represents the second terrace at this locality.

The following table gives the elevation of the terraces at representative points in the county:

	Mouth of Seneca. Feet.	Franklin. Feet.	Upper Tract. Feet.	Sugar Grove. Feet.
3rd Terrace...	1760	1830–50	1560±	1960
2nd Terrace...	1660	1730±	1510	1865–70
1st Terrace...	1570	1700–05	1455	1835
Flood-plain ...	1545	1680–85	1420–25	1808–10
River	1535	1675	1415	1800

[3]Wright, Frank J., loc. cit.

PLATE VIII.—Mouth of Seneca. There is a flood-plain seven feet above the river. The terrace on which the houses are built stands twenty feet above the river. The high terrace is 190 feet above the low terrace, and about half-way between these two terraces is an inconspicuous terrace. The line of River Knobs appears at the right. The picture is taken from the second terrace just south of Mouth of Seneca, looking northeast. (Photo. by John L. Tilton).

PRESENT TOPOGRAPHIC FEATURES.

The general relief of Pendleton County is that of a very complexly folded region, with some faulting, that has been subsequently dissected by stream erosion. The three major streams, South Branch, South Fork, and North Fork of the Potomac River, have cut deep gorges the entire length of the county and divided it roughly into four parts, that is, the area from the crest of Allegheny Mountain to the North Fork of the Potomac River, another from the North Fork of the Potomac River to the South Branch of the Potomac River, still another from the latter river to the South Fork of the Potomac River, and finally the remaining area to the crest of the Shenandoah Mountain.

On the west Allegheny Mountain marking the Allegheny Front makes steep precipitous escarpments and retains elevation of 4,700 feet and above. The northern half of this mountain in Pendleton County is capped by a conglomerate of the Pottsville Series. Lying just east of Allegheny Mountain is Spruce Mountain, which retains the highest point in the State (Spruce Knob—4860′) and is also capped by the Pottsville Conglomerate. Along the eastern border of the county is Shenandoah Mountain, a synclinal structure with several points remaining above 4,000 feet in elevation, with the youngest remaining rock Pocono Sandstone. All of the above mountains are ascribable almost entirely to stream erosion which has greatly dissected the Schooley Peneplain and produced numerous V-shaped valleys along their flanks.

Immediately east of the North Fork of the Potomac River is the great overturned North Fork Mountain Anticline with the eastern limb forming North Fork Mountain with elevations of 4,566 feet at Kile Knob and approximately 3,200 feet at the Grant County line. The crest of this anticline has been eroded to form a deep valley in the Martinsburg Shale and underlying Shenandoah Limestone with the resistant Medinas forming precipitous cliffs on either side.

The area between North Fork Mountain and South Fork River is a succession of interfingering folds that are held up principally by the White Medina and Oriskany Sandstones.

With the exception of Jack Mountain, this area in general is approximately 3,000 feet or near the level of the Harrisburg Peneplain. The area between the South Fork River and the Virginia State line is the western limb of the great Shenandoah Mountain Syncline, with the State line marking approximately the axis of the syncline. Other than a few high points that are capped by the Pocono Sandstone, the greater part is Catskill Shale and Sandstone deeply dissected on either side by V-shaped valleys.

The highest point in the area is Spruce Knob with an elevation of 4,860 feet above sea-level with the lowest point at the Grant County line along the South Branch of the Potomac River with an elevation of 1,155 feet above sea-level.

Allegheny Mountain.—Allegheny Mountain, the crest of which marks the western border of the county, is one of the longest, if not the longest, continuous mountains in the State with an approximate length of one hundred and forty miles. This mountain has its beginning on the south at the junction of Greenbrier and Monroe Counties, West Virginia, and Alleghany County, Virginia, where it is first called Allegheny, and continues northeast, marking the eastern border of the State along Greenbrier and Pocahontas Counties to Pendleton where it marks the western limit of this county and continues across Grant and Mineral Counties to the Potomac River where it passes into Maryland. At its southern end it has an elevation of 3,200 feet and rises to 4,530 feet in Pocahontas. In Pendleton it reaches an elevation of 4,760 feet on Roaring Plains and descends to near 3,000 feet west of Keyser. Its eastern escarpment is designated as "Allegheny Front".

Spruce Mountain.—Immediately east of Allegheny Mountain is Spruce Mountain lying about midway between the northern and southern limits of the county. It is a high synclinal structure capped by the resistant Pottsville Conglomerate. It extends northeast-southwest for approximately sixteen miles. It has an average elevation of 4,600 feet, with Spruce Knob, the highest point in the State, standing at an elevation of 4,860 feet above sea-level.

River Knobs.—A line of knobs lying directly east and paralleling the North Fork of the Potomac River are called

River Knobs, standing nearly vertical the entire length of the county. They are formed by the resistant Medinas. It is this cliff of White Medina that makes the beautiful Seneca Rocks at the Mouth of Seneca.

North Fork Mountain.—North Fork Mountain is the main barrier between the waters of North Fork and South Branch of the Potomac River. It is a high resistant ridge with an even crest-line extending in a northern direction across Pendleton County for a distance of twenty-seven miles and into Grant County for a distance of six miles where it is cut across by the North Fork of the Potomac, after which it is known as New Creek Mountain. This mountain marks the eastern limb of the great North Fork Mountain Anticline and is capped by the resistant White Medina Quartzite. At Kile Knob near its southern end it has an elevation of 4,566 feet. At Harmon Rocks it stands at 4,054 feet, High Knob 3,795 feet, and Chimney Rock at its northern end at 3,140 feet.

Shenandoah Mountain.—The massive Shenandoah Mountain extending from Fort Lewis on Cowpasture River into southern Hardy County is synclinal in structure, the crest of which along the eastern border of Pendleton County marks the State line. It is an important drainage divide and because of its massive character constitutes a great barrier to the movement of the population. The greater part of the cap rock is Catskill Shale and Sandstone with a few high points still retaining the Pocono Sandstone. It retains elevations of 4,000 to 4,300 feet above sea-level.

South Fork Mountain.—South Fork Mountain which is the southern extension of Elkhorn Mountain enters Pendleton County from the north at the common corner of Grant, Hardy, and Pendleton Counties. It continues southwest across the county in the form of numerous folds of Oriskany Sandstone that are often worn through to the underlying limestones. These folds assume names other than South Fork Mountain such as Dickinson Mountain, Stone Mountain, and Bullpasture Mountain. This entire region retains an average elevation of 3,000 feet. The entire region between the South Branch and the South Fork of the Potomac River contains a number of irregular ridges crossed by many gaps, some of which are as low

as 2,300 to 2,400 feet. The highest summit extends to over 3,000 feet. The remaining prominent ridges in this region are Jack Mountain and Long Ridge capped by the White Medina Quartzite, with Sandy Ridge, Thorn Mountain, and Neds Mountain capped by the Oriskany Sandstone.

Cave Mountain.—Cave Mountain enters Pendleton County from Grant County on the north and extends southwestward to a point three miles north of Upper Tract where it is cut across by the South Branch of the Potomac River. From this point it separates southeastward into numerous folds and ridges called by the following names: Big Mountain, Pretty Ridge, Timber Ridge, Bullalo Hills, Peters Mountain, Castle Mountain, Colic Mountain, Lankey Mountain, Ruleman Mountain, Bobs Mountain, and Simmons Mountain. The cap rocks are principally Oriskany Sandstone and White Medina Quartzite. The average elevation of this area is 3,000 feet above sea-level.

DRAINAGE BASINS.

A general view of the drainage system of Pendleton County is shown on Figure 4. A detailed study can be made of the streams from Maps I and II, which are to be found in the Atlas accompanying this Report, showing their relation to the topography, geology, and structure. The major streams, in general, parallel the mountain ranges while the minor streams have cut across them at right angles.

TABLE OF STREAM DATA.

The following table prepared by the writer (Paul H. Price) gives a list of all the principal streams of Pendleton County, the length of the streams as well as the air-line distance from source to mouth, also the total fall of the streams and rate of fall per mile. In the last column is given the ratio of the meander distance or total distance (T. D.) to the air-line distance (A. L. D.):

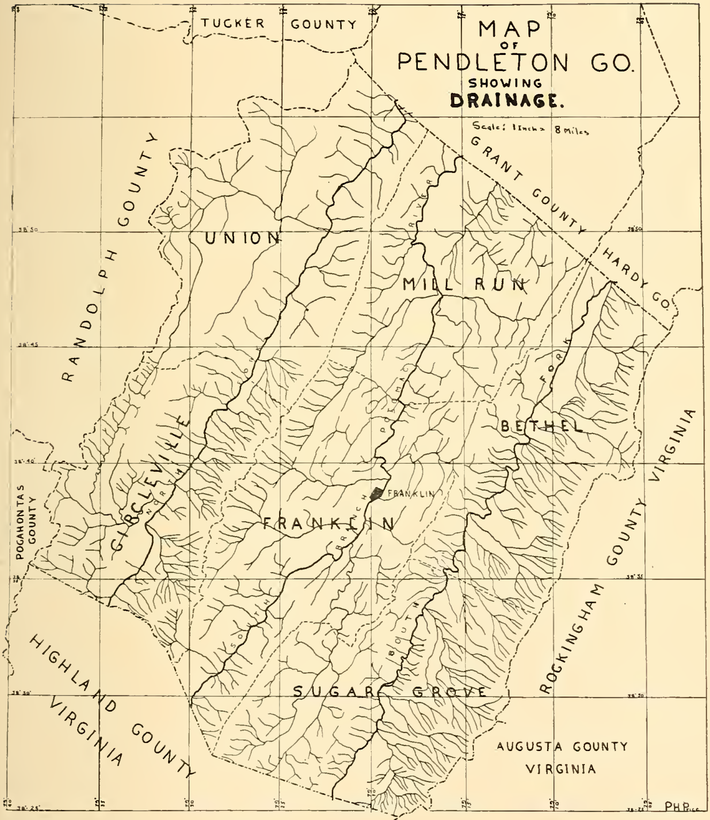

Figure 4.—Map of Pendleton County showing Drainage System.

Table of Stream Data.

STREAMS.	Total Distance. Miles.	Total Fall. Feet.	Rate of Fall per Mile—Feet.	Air-line Distance—Miles.	Ratio T. D. to A. L. D.
South Branch Potomac River	131.15	3065	23.37	94.40	1.39
South Branch (In Pendleton County)	39.0	1145	29.35	31.3	1.24
North Fork Potomac River	57.7	3010	52.16	47.7	1.21
North Fork Potomac River (In Pendleton County only)	33.2	1355	40.81	29.6	1.12
Zeke Run	2.85	1560	547.36	2.7	1.055
Shafter Run	2.6	1340	515.38	2.55	1.02
Sawmill Run	2.5	1165	466.00	2.15	1.16
Big Run	2.65	1390	524.52	2.25	1.18
Seneca Creek	19.3	2550	132.12	11.5	1.68
Brushy Run	7.6	2230	293.42	7.05	1.08
Roaring Creek	5.6	1045	186.61	5.15	1.09
White Run	4.35	1500	344.82	3.3	1.32
Mill Creek (Judy Spring)	2.9	850	293.10	2.35	1.23
Root Run	3.85	1475	383.11	2.7	1.425
Blizzard Run	3.3	2125	643.93	2.9	1.14
Briery Gap Run	3.0	2175	725.00	2.7	1.11
Laurel Run	3.35	2400	716.42	3.1	1.08
Red Lick Run	2.95	2145	727.12	2.9	1.02
Teter Run	3.2	1685	526.56	2.9	1.10
Big Run	12.8	1725	134.76	5.95	2.15
Dry Run	5.0	1300	260.00	4.45	1.12
Laurel Fork (Pendleton-Highland County)	15.0	1505	100.33	11.3	1.33
Straight Fork	9.05	1030	113.81	8.03	1.13
Mill Creek (Junction of North and South Mill Creeks to mouth)	2.64	40	15.15	2.45	1.08
North Mill Creek	16.13	1160	71.92	12.23	1.32
Brushy Run	5.52	900	163.04	4.57	1.21
Stony Creek	2.91	330	113.40	2.50	1.16
South Mill Creek	14.01	600	42.83	11.48	1.22
Kessner Run	3.14	890	283.44	2.92	1.08
Long Run	3.15	925	340.54	2.8	1.125
Briggs Run	4.35	850	195.40	3.8	1.14
Reeds Creek	12.25	1290	105.31	10.9	1.12
Mill Run	9.9	1210	122.22	7.55	1.31
Deer Run	8.25	1190	144.24	5.7	1.45
Hammer Run (Mill Run-Franklin District)	4.45	1020	229.21	2.95	1.51
Peters Run	4.15	910	219.28	3.4	1.22
Trout Run (Troublesome Valley)	7.6	1025	134.86	5.55	1.37
Friends Run	8.15	2115	259.51	7.0	1.16
Props Run	2.88	1035	357.64	2.45	1.18
Smith Creek	10.4	2240	215.38	8.07	1.29
Thorn Creek (to forks of Whitethorn and Blackthorn Creeks)	9.0	395	43.89	6.1	1.48

Table of Stream Data.—(Continued)

Whitethorn Creek	8.0	570	71.25	7.1	1.13
Blackthorn Creek	8.7	1100	126.44	7.25	1.20
Moyer Run	3.1	1250	403.22	2.85	1.09
Hammer Run (Franklin District)	4.3	1200	279.07	3.0	1.43
East Dry Run	4.7	1150	244.68	3.95	1.19
South Fork (Moorefield) River	64.4	1800	27.95	52.4	1.23
South Fork (Moorefield) River (In Pendleton County only)	37.5	925	24.66	29.7	1.26
Kettle Creek	6.8	790	116.18	6.24	1.09
Wilson Run	3.84	1160	302.08	3.25	1.18
Camp Run	3.7	1710	462.18	3.1	1.19
Straight Run	4.15	1490	467.47	4.0	1.04
Rough Run	6.25	1850	296.00	5.4	1.16
Fisher Run	4.35	1390	319.54	3.85	1.13
Dice Run	3.97	1570	395.46	3.62	1.10
Wagner Run	3.5	1370	391.42	3.4	2.02
Stony Run	4.22	1605	380.33	3.93	1.07
Road Run	4.45	1470	330.33	4.12	1.08
Hawes Run	6.05	1800	297.52	5.64	1.07
Broad Run	6.55	1675	255.72	5.72	1.15
Miller Run	6.6	1725	261.36	6.03	1.09
Little Fork	8.55	2095	245.03	5.95	1.44
Stony Run (Sugar Grove District)	6.22	2030	326.37	5.45	1.14
Brushy Fork (Sugar Grove Districts	8.33	1570	188.48	8.0	1.19

DRAINAGE AREAS OF PENDLETON COUNTY.

The following table, prepared by the writer (Paul H. Price), gives a list of the principal streams of Pendleton County with their drainage area computed by planimeter from the topographic maps made jointly by the U. S. Geological Survey and the West Virginia Geological Survey:

Areas of Drainage Basins.

STREAMS.	Square Miles.
South Branch Potomac River	1492.66
South Fork (Moorefield) River	334.02
North Fork Potomac River	326.06
Zeke Run	2.33
Shafter Run	2.50
Sawmill Run	2.98
Big Run	2.69
Seneca Creek	68.37
Brushy Run	10.29
Roaring Creek	14.06
White Run	6.07
Mill Creek (Judy Spring)	8.54
Root Run	8.61
Blizzard Run	2.45
Briery Gap Run	2.31
Laurel Run	4.44

Areas of Drainage Basins—(Continued).

STREAMS.	Square Miles.
South Branch Potomac River:	
Red Lick Run	2.45
Teter Run	3.73
Big Run	28.64
Dry Run	9.50
Laurel Fork (Pendleton-Highland County)	28.70
Straight Fork	9.96
Mill Creek (Grant and Pendleton Counties)	103.66
North Mill Creek	47.42
Brushy Run	7.22
Stony Creek	4.33
South Mill Creek	46.71
Kessner Run	3.24
Long Run	3.15
Briggs Run	6.37
Reeds Creek	20.09
Mill Run	16.95
Deer Run	7.54
Hammer Run	5.77
Peters Run	5.12
Trout Run	17.61
Friends Run	12.68
Props Run	3.43
Smith Creek	20.74
Thorn Creek	50.91
Whitethorn Creek	15.49
Blackthorn Creek	19.44
Moyer Run	6.38
Hammer Run (Franklin District)	4.63
East Dry Run	5.59
South Fork (Moorefield) River:	
Kettle Creek	21.29
Wilson Run	4.77
Camp Run	5.80
Straight Run	2.21
Rough Run	10.35
Fisher Run	3.25
Dice Run	2.91
Wagner Run	1.80
Stony Run	3.12
Road Run	4.13
Hawes Run	9.23
Broad Run	5.59
Miller Run	5.91
Little Fork	17.33
Stony Run (Sugar Grove District)	8.00
Brushy Fork (Sugar Grove District)	13.52

DESCRIPTION OF DRAINAGE BASINS.

South Branch of the Potomac River.—The South Branch of the Potomac River is the principal drainage basin of Pen-

dleton County and has its source near Monterey, Highland County, Virginia. It flows in a northeast direction across Pendleton County to four miles west of Petersburg, Grant County, where it is joined by the North Fork River. From this intersection it flows almost due east for a distance of nine miles where it again turns northeast to Moorefield, Hardy County, where it is joined by the South Fork (Moorefield) River. From this latter place it continues northeast, following, in general, the trend of the mountains to near French Station (South Branch P. O.) where it joins the North Branch of the Potomac to form the Potomac River.

The river flows, in general, in the synclinal basins paralleling the mountain ranges, but occasionally cuts across major folds, which is evidence that this stream was well entrenched upon the Schooley Peneplain long before this present level was reached.

The South Branch of the Potomac River has a meandering length of 131.15 miles with an air-line length of 94.4 miles and a total fall of 3,065 feet or at the rate of 23.37 feet per mile. Its drainage area is 1,492.66 square miles.

Mill Creek.—(North and South Mill Creeks).—The following description by Reger of Mill Creek and its main branches is taken from page 73 of the Mineral-Grant County Report of the Survey:

"**Mill Creek.**—Mill Creek, emptying into the south side of South Branch 1½ miles below Petersburg, is composed of two branches known as North Mill Creek and South Mill Creek, respectively, that join currents only 2½ miles above the mouth of the parent stream, the entire drainage area of Mill Creek and the two branches being 103.66 square miles. **North Mill Creek** rises in Pendleton County just north of Kline, flows northeastward and joins South Mill Creek at Hiser, its length being 16.13 miles, its total fall 1,160 feet, making a rate of 71.92 feet per mile, and the area of its drainage basin 47.42 square miles. Its current is gentle, there being a narrow valley with many short meanders of recent origin. **South Mill Creek** rises in Pendleton County 2½ miles northeastward from Kline, flows northeastward to Rough Run and thence almost northward to the junction with North Mill Creek, its length being 14.01 miles, its total fall 600 feet, making a rate of 42.83 feet per mile, and the area of its drainage basin 46.71 square miles. Its valley is of about the same width as that of North Mill Creek and the current of the stream is much the same."

Brushy Run.—Brushy Run, a tributary to North Mill

Creek, heads southwest of High Rock School on the west side of South Fork Mountain and flows in a northwest course to where it joins North Mill Creek 0.7 mile northeast of Brushy Run P. O. It has a total length of 5.52 miles with a drainage area of 7.22 square miles.

Reeds Creek.—Reeds Creek has its source in several small tributaries on the east side of North Fork Mountain and west of Peters Mountain. It follows the basin between these two folds to one mile southwest of Upper Tract where it turns east across two Oriskany anticlines to join the South Branch one-half mile east of Upper Tract. For a considerable distance the stream passes along limestone strata and consequently often follows underground passages through them. Reeds Creek has a total length of 12.25 miles with a fall of 1,290 feet or at the rate of 105.31 feet per mile. It has a drainage area of 20.09 square miles.

Mill Run.—This particular Mill Run has its source in Shaver Run on South Fork Mountain just northwest of the common corner of Grant, Hardy, and Pendleton Counties in Grant County. It flows southwest along this mountain to one mile east of Greenawalt School where it turns west, cutting across resistant sandstone folds and passes through the village of Kline to join the South Branch directly east of Upper Tract. This stream has a length of 9.9 miles with a drainage area of 16.95 square miles.

Water from this stream is used to turn the big overshot wheel for the mill at Kline.

Deer Run.—Deer Run also heads on the west side of South Fork Mountain near Deerrun Post-Office. It flows northwest at right angles to the folds for three miles and then northeast paralleling the folds for 1½ miles where it again turns northwest, passing by Mt. Horeb Church to joint the South Branch east of Upper Tract. It has a total length of 8.25 miles with a fall of 1,190 feet or at the rate of 144.24 feet per mile. Its drainage area is 7.54 square miles.

Hammer Run.—Hammer Run is a small tributary of the South Branch that joins it at Ruddle. It has its source on the northeast end of Peters Mountain in Whetstone Run and is

joined by the small runs of Strauter, Brady Gap, and Buffalo.

Trout Run.—Trout Run, so named because of its good fishing is made up of several small streams from the folded area northeast of Franklin. Its tributaries are Dry, Spruce, and Paddy Runs. It joins the South Branch one mile north of Franklin. It has a drainage area of 17.61 square miles.

Friends Run.—Friends Run has its source high on the east side of North Fork Mountain and is followed, in general, by the old Franklin-Circleville road to near the crest of North Fork Mountain. It flows almost due east irrespective of rock structure to join the South Branch 3/4 mile north of Franklin. It has a total length of 8.15 miles with a total fall of 2,115 feet or at the rate of 259.51 feet per mile. It has a drainage area of 12.68 square miles.

Smith Creek.—Smith Creek has its source in the south end of a canoe-shaped basin at the intersection of North Fork and Ruleman Mountains. It flows northeast for a distance of 4.2 miles to near Goshen School where it is joined by Twin Run from the northwest and jointly they cut a deep gap between Ruleman and Castle Mountains and continue east across this complexly folded area to the South Branch of the Potomac River 2 miles south of Franklin.

Smith Creek has a meandering length of 10.4 miles with a total fall of 2,240 feet or at the rate of 215.38 feet per mile. It has a drainage area of 20.74 square miles.

Thorn Creek.—Thorn Creek with its two largest tributaries, Whitethorn and Blackthorn Creeks, is the largest tributary of the South Branch River in Pendleton County. **Whitethorn Creek** heads just south of the Pendleton County line near Doe Hill, Highland County, Virginia, while **Blackthorn** heads near the southern border of Pendleton County. These two streams flow northeast paralleling either side of Thorn Mountain. At Johnstown (Moyers P. O.) Whitethorn Creek turns northwest across Thorn Mountain and joins Blackthorn to form Thorn Creek proper. Thorn Creek continues its course northward in a well-entrenched meander across numerous Oriskany folds to join the South Branch at McCoys Mill. This mill was formerly run by water from Thorn Creek. Thorn Creek to the head of Whitethorn Creek has a total

length of 17 miles with a drainage area of 50.91 square miles.

South Fork (Moorefield) of Potomac River.—The South Fork (Moorefield River) of the Potomac River has its source 11 miles east of Monterey and 2.5 miles south of the Pendleton County line in Highland County, Virginia. It flows between the Shenandoah and South Fork Mountains across Pendleton County into Hardy and empties into the South Branch at Moorefield. With one exception, where it cuts across an Oriskany fold for a distance of three miles just south of the Hardy County line, it follows the weak Lower Devonian Shales its entire length.

In the present report the original name of South Fork is used. On the old U. S. Topographic Quadrangles on the scale of two miles to the inch it was called the South Fork River, but on the later U. S. Topographic Quadrangles on the scale of one mile to the inch it was changed by the U. S. Geographic Board to Moorefield River. In that South Fork is the true and original name it is so designated in this report and on the accompanying maps, this second change also having been made by the U. S. Geographic Board. As this change was not authorized before the Hampshire-Hardy County Report and Maps were printed and engraved the name Moorefield River was used on those maps and hence the term "Moorefield" is retained as a synonym in this report to avoid confusion.

The South Fork has a meandering length of 64.4 miles with an air-line length of 52.4 miles with a total fall of 1,800 feet or at the rate of 27.95 feet per mile. It has a drainage area of 334.2 square miles.

Kettle Creek.—Kettle Creek is one of the minor tributaries to South Fork (Moorefield River) and has its source near the western end of Sweedlin Hill and flows in a northeast course paralleling the east side of this ridge to where it joins the South Fork (Moorefield River) at the Pendleton-Grant County line. The tributaries to Kettle Creek in ascending order are: Wilson, Camp, Lick, and Bucklick Runs. Kettle Creek has a length of 6.8 miles with a drainage area of 21.29 square miles.

Rough Run.—Rough Run has its source high up on the west slope of Shenandoah Mountain and flows northeast cutting across the southern end of Sweedlin Hill to join the South

Fork (Moorefield River) 1.2 miles northeast of Fort Seybert. Rough Run has a length of 6.25 miles with a fall of 1,850 feet or at the rate of 296 feet per mile.

Hawes Run.—Hawes Run also heads high up on the west slope of Shenandoah Mountain and flows northeast, roughly paralleling the Brandywine-Harrisonburg road and joins the South Fork (Moorefield River) just north of Brandywine. It has a length of 6.05 miles with a drainage area of 9.23 square miles.

Broad Run.—Broad Run heads on the west slope of the Shenandoah Mountain with an elevation of 3,250 feet and flows in a northwest direction to the South Fork (Moorefield River) ½ mile south of Brandywine. It has a total length of 6.55 miles with a drainage area of 5.59 square miles.

Miller Run.—Miller Run also has its source near the crest of Shenandoah Mountain and flows in a northwest course across the Devonian Shales to join the South Fork (Moorefield River) 2 miles south of Brandywine. It has a length of 6.6 miles with a total fall of 1,725 feet or at the rate of 261.36 feet per mile. It has a drainage area of 5.91 square miles.

Little Fork.—Little Fork is the longest tributary to the South Fork (Moorefield) River in Pendleton County, with a length of 8.55 miles. It heads on Shenandoah Mountain south of the Shenandoah Tower and flows in a circular direction from southwest to northwest to join the South Fork (Moorefield) River ½ mile southwest of Lone Poplar School. Little Fork has the following small tributaries: Thorny, Lick, Sugar, Seng, and Wolf Runs. It has a length of 8.55 miles with a drainage area of 17.33 square miles.

Brushy Fork.—Brushy Fork has its source south of the Pendleton County line in Highland County, Virginia, between Shaw Ridge and Shenandoah Mountain. It flows northeast between these barriers to Brushy Fork School where it turns northwest across the northern end of Shaw Ridge and joins the South Fork (Moorefield River) 0.2 mile south of Wilfong School. Its tributaries in Pendleton County are Flesher, Broad, and New Road Runs. Brushy Fork has a length of 8.33 miles with a drainage area of 13.52 square miles.

North Fork of Potomac River.—The North Fork of Poto-

mac River has its source in Laurel Fork heading 6 miles northwest of Monterey, Highland County, Virginia, between Middle and Allegheny Mountains. This fork flows northeast in a well-entrenched meander to the Pendleton County line where it turns due east for 1½ miles to join Straight Fork. From this latter point it continues in a northeast direction entirely across the county, roughly paralleling the vertical cliffs of Medina Quartzite that makes the River Knobs. Near the Pendleton-Grant County line this stream turns northwest for a distance of 1.2 miles, cutting across the Oriskany Sandstone, then continuing northeast again to Hopeville School where it turns almost due east, cutting a deep gorge across the great North Fork Mountain to join the South Branch 4 miles west of Petersburg.

North Fork River has a meandering distance of 57.7 miles with an air-line distance of 47.7 miles with a total fall of 3,010 feet or at the rate of 52.16 feet per mile. It has a drainage area of 326.06 square miles.

Seneca Creek.—Seneca Creek, the largest tributary of the North Fork River, has its source between Spruce Mountain and Allegheny Mountain northwest of Spruce Knob. It flows northeast along a deep V-shaped valley for a distance of 12 miles where it turns east, cutting across the northern end of Spruce Mountain, passing through Onego to join the North Fork at Mouth of Seneca. Its tributaries in ascending order are: **Brushy Run** that heads between Spruce Mountain and Timber Ridge and flows in a northeast direction for a distance of 7.6 miles to join Seneca Creek ½ mile southeast of Onego; **Roaring Creek** with its tributaries, Long Run and Elklick Run, heads high up on the Allegheny Front near Roaring Plains and flows in a southern direction to join Seneca Creek at Onego. White, Horsecamp, and McIntosh Runs are smaller tributaries heading along the Allegheny Front. Seneca Creek has a length of 19.3 miles with a fall of 2,550 feet or at the rate of 132.12 feet per mile. It has a drainage area of 68.37 square miles.

Big Run.—Big Run, like Seneca Creek, heads between Spruce Mountain and Allegheny Mountain northwest of Spruce Knob but flows in the opposite (southwest) direction

PLATE IX.—View from top of Seneca Rock, to the northwest. In the foreground is the North Fork River. The prominent relief in the middle background is Smith Mountain. In the extreme right and left background can be seen Roaring Plains marking the Allegheny Front. (Photo. by West Virginia Photo Co., Thomas, W. Va.)

for approximately six miles where it is joined by Elk Run, and together they cut a deep valley across the southern extension of Spruce Mountain to join the North Fork 3 miles southwest of Circleville. Big Run has several small tributaries in Cold Spring, Sawmill Branch, Back, Teter Camp, and Elk Runs. Big Run has a drainage area of 28.64 square miles.

Laurel Fork.—Laurel Fork and **Straight Fork,** lying almost entirely in Highland County, Virginia, have their source on the west and east side, respectively, of Middle Mountain, and flow northeast, parelleling this mountain to the Pendleton County line where Laurel Fork turns east across this latter mountain to join Straight Fork, the two continuing as North Fork River.

WATER-POWER.

PRESENT DEVELOPMENT.

At present the many streams of Pendleton County are used for the development of power only on a very small scale. Other than the local power plant at Franklin, their use for power is limited to propelling overshot wheels for the grinding of flour and feed. In the latter way as many as fifteen small mills are operated intermittently throughout the season. These mills are as follows:

Name of Mill.	Stream.	Location.
Dolly	Roaring Creek	½ mile from Onego.
Boggs	North Fork	1½ miles above Mouth of Seneca.
McDonald	North Fork	Macksville.
Dove	North Fork	Riverton.
Nelson	North Fork	Circleville.
Dove	Big Run	3 miles southwest of Circleville.
Simmons	South Branch	Cave.
McCoy	Thorn Creek	3 miles south of Franklin.
Byrd	South Branch	Ruddle.
Lough and Company	South Branch	1 mile north of Upper Tract.
Hevener	Mill Run	Kline.
Cowger	South Fork	Fort Seybert.
Hoover	South Fork	Brandywine.
Kiser	South Fork	Sugar Grove.
Mitchell	South Fork	1 mile south of Sugar Grove.

These mills are evenly distributed over the county. The first six are located in the western part along the waters of the North Fork or its tributaries, the next five along the South

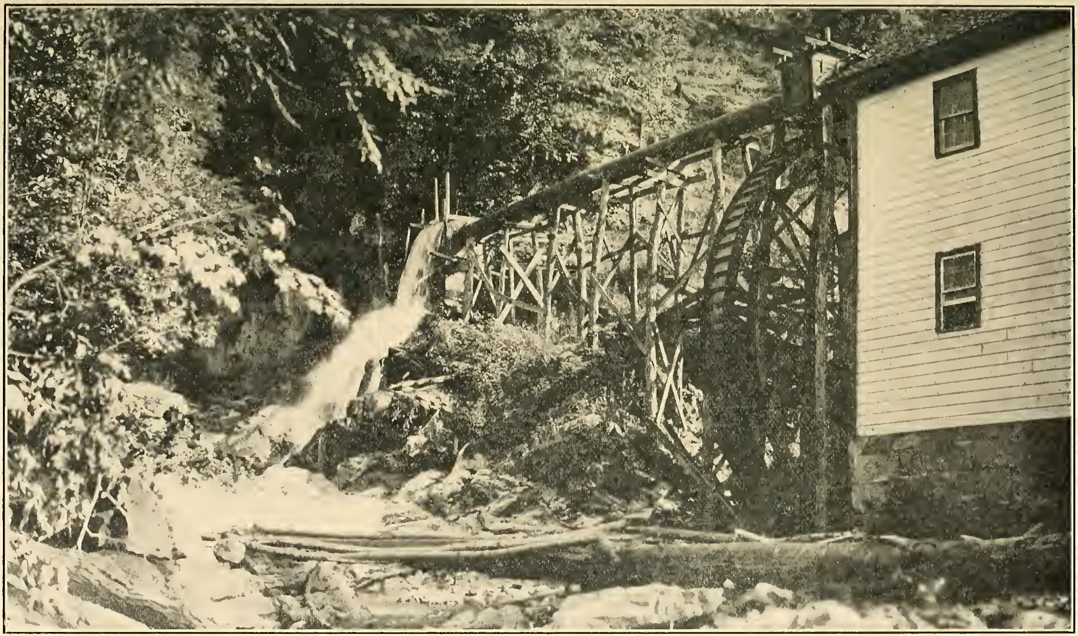

PLATE X.—Kline Mill. Here the miller is utilizing the water of Mill Run as it falls over an Oriskany Sandstone ledge to propel a 30-foot diameter overshot wheel. (Photo. by Paul H. Price).

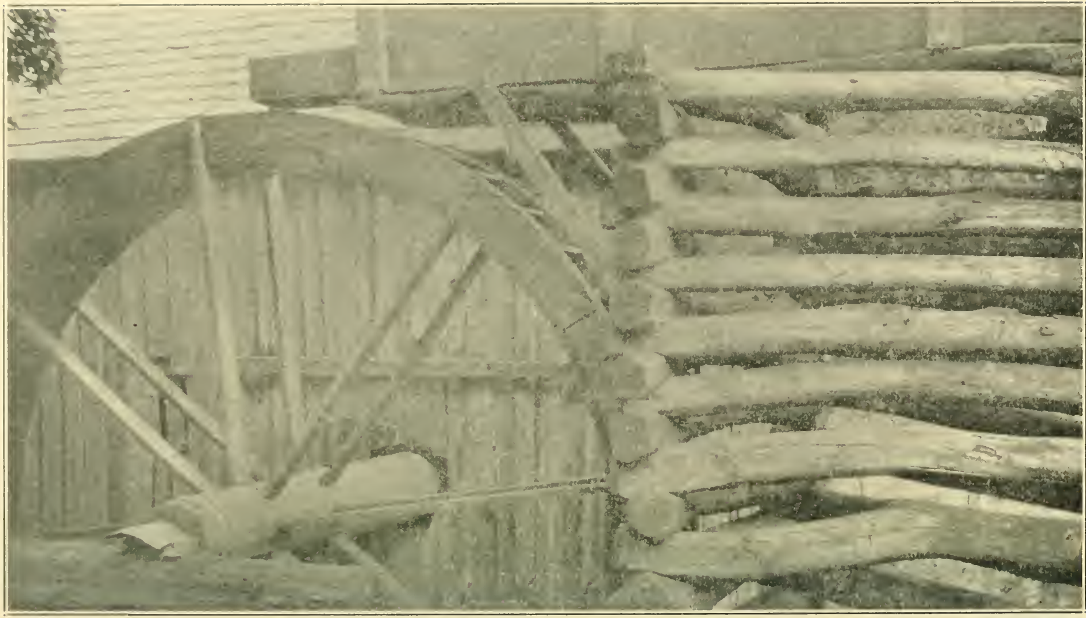

PLATE XI.—Ketterman Mill on Brushy Run, where the water comes from a cave in the Greenbrier Limestone. This is an old-time mill site. (Photo. by John L. Tilton).

Branch or its tributaries, and the last four along the South Fork. These mills vary somewhat as to capacity, but none very large. The largest overshot wheel seen was on the Hevener Mill at Kline, having a diameter of 30 feet.

At Franklin a small part of the South Branch of the Potomac River is utilized to generate electric current for the town and also to pump water to the reservoir that serves the town.

AVAILABLE STREAMS.

In Pendleton County the streams most suitable for commercial power development are South Branch of the Potomac River, North and South Forks of the South Branch of the Potomac River. Other than these principal streams are numerous smaller ones that could be used advantageously for local power, since there is no coal of minable thickness in the county, and there are many natural water-power sites. As pointed out in the preceding paragraph many of the smaller streams are now used in running small grain and feed mills. As Pendleton County is largely wooded a fairly constant water-supply would be insured throughout the year.

South Branch of the Potomac River.—The drainage basin of the South Branch of the Potomac River has already been described on pages 44-45 along with a table of stream data. This river passes entirely across Pendleton County from south to north and roughly bisects it, and is joined by the North Fork four miles west of Petersburg, Grant County. From Royal Glen Mill, one mile east of the junction of these two streams in Grant County, to Upper Tract in Pendleton County the river is gorge-like in character and affords many feasible sites for dams that would inundate very little valuable land. The most favorable location for a major project would be at Royal Glen Mill in Grant County. (See Mineral and Grant Report). Here there is a favorable site that would include the drainage from both the South Branch and North Fork. The only uncertainty is the possibility of underground passages in the limestone that the streams cross. It is the writer's opinion that such would not be the case.

From the Grant-Pendleton County line to Upper Tract

the South Branch of the Potomac River passes through the Smoke Hole Settlement, a passage almost gorge-like in character with many possible locations for power projects unless it should prove to be cavernous. From Upper Tract to the county line the river falls 245 feet or a fall necessitating three 80-foot dams to pond the water to the vicinity of Upper Tract. The damage to the area flooded would be practically negligible.

For minor projects south along the remainder of the river there are other points suitable for power sites with the uncertainty, however, of underground outlets through the limestone.

An attempt was made to dam the South Branch of the Potomac River below the mouth of Trout Run near Franklin but was washed out before completion. There would seem to be no reason why this proposed project could not be carried to completion and supply the town of Franklin with electric current.

North Fork of the South Branch of the Potomac River.—The drainage basin of the North Fork of the South Branch of the Potomac River has already been described on pages 49-50 along with a table of stream data. Along this stream within the limits of Pendleton County there are few favorable dam sites. This stream also follows strata of sandstone, limestone, and shale that stand practically vertical thus presenting the hazard of ponded water finding an outlet through underground passages. There is one point, however, that comes within the limits of the Monongahela National Forest purchase area that does seem favorable. Near Evergreen Church the North Fork cuts across the Oriskany Sandstone cutting a narow pass suitable for a dam site. A dam here would not only provide power for any electric current that would be needed but would also create an artificial lake thus adding another attractive feature to the proposed park area.

South Fork of the South Branch of the Potomac River.—The drainage basin of the South Fork of the South Branch of the Potomac River has already been described on pages 47-48 along with a table of stream data. Other than for a limited local use there would seem to be no demand for hydroelectric power in this immediate area. If at any future time the de-

mands should require it a favorable location can be secured at the mouth of Straight Run. Here the South Fork cuts across the west limb of an Oriskany anticline to make a suitable site for a power dam. The inundated area would not be expensive and other conditions are favorable.

Indicated Horse-Power of Streams.

The following table gives the indicated horse-power developed by streams in Pendleton County, in whole or in part, and was taken from Tables 22 and 23, pages 434 and 435, of the Semi-Centennial History of West Virginia, by Dr. J. Morton Callahan, being part of a special article on "Water Power Resources of West Virginia" by A. H. Horton, District Engineer, Water Resources Branch, United States Geological Survey. For stream lengths, total fall, rate of fall, etc., computed on the latest United States Geological Survey maps, see "Table of Stream Data", pages 42-43:

Indicated Horse-Power Developed by Tributaries of South Branch Potomac River.

Stream.	Section. From.	Section. To.	Length In Miles.	Total Drainage Area. Square Miles.	Minimum Discharge. Second-feet.	Assumed Discharge for Maximum Development. Second-feet.	Total Fall. Feet.	Minimum Horse-Power.	Assumed Maximum Development. Horse-Power.
Thorn Creek	Source	South Branch Potomac River	15	50	6.5	22	1,500	224	775
North Fork South Branch Potomac River	Source	Above Big Run	20	63	8.2	28	1,750	330	1,140
North Fork South Branch Potomac River	Below Big Run	Above Seneca Creek	16	a140	18.2	63	700	1,170	4,060
North Fork South Branch Potomac River	Below Seneca Creek	South Branch Potomac River	18	a280	36.4	126	550	1,840	6,380
Seneca Creek	Source	North Fork South Branch Potomac River	20	61	7.9	27	2,500	454	1,570
Lunice Creek	Source	South Branch Potomac River	20	92	12.0	41	2,000	551	1,900
North and South Forks, Mill Creek	Source	South Branch Potomac River	25	100	13.0	45	2,000	597	2,060
South Fork Potomac River (Moorefield River)	Source	Below Little Fork	17	73	9.5	33	1,200	262	905
South Fork Potomac River (Moorefield River)	Below Little Fork	South Branch Potomac River	44½	a186	24.2	84	970	2,160	7,500
Mill Creek	Source	South Branch Potomac River	15	52	6.8	23	800	125	430
Totals								7,713	26,720

a—Total area.

Indicated Horse-Power Developed by South Branch Potomac River.

Section of River. From.	To.	Length In Miles.	Mean Drainage Area. Square Miles.	Minimum Discharge. Second-feet.	Assumed Discharge for Maximum Development. Second-feet.	Total Fall. Feet.	Minimum Horse-Power.	Assumed Maximum Development. Horse-Power.	Horse-Power Available from Storage for 12 mos.	6 mos.	3 mos.
Source	Above Thorn Creek	25	a103	13.4	46	1,700	524	1,800	......	......	......
Below Thorn Creek	Above North Fork of South Branch Potomac River	35	236	30.7	107	810	2,280	7,970	......	......	......
Below North Fork South Branch Potomac River	Romney	40½	1,025	131.0	459	b323	3,890	13,600	10,600	21,200	42,400
Romney	Mouth	29½	1,450	189.0	653	127	2,210	7,630	6,000	12,000	24,000
Totals		130	......	......	......	2,960	8,904	31,000	16,600	33,200	66,400

a==Total area.
b==Fall reduced to 223 feet by proposed reservoir.

PART II.

Geology.

CHAPTER III.

ROCKS OF PENDLETON COUNTY BELOW THE CLINTON.

By Wm. F. Prouty.

INTRODUCTION.

The area of exposure of the rocks older than the Clinton in Pendleton County, is confined to a belt about eleven miles in width. This belt, which has a trend of about forty degrees east of north throughout the county, is an unsymmetrical geanticlinal structure whose western limb is more steeply inclined than the eastern. On this account deeper erosion has occurred toward the western side of this eleven-mile strip and it is here that the older rocks are exposed. Toward the east side of the geanticline the Medina folds usually form anticlinal mountains with unbroken arches, and due to the plunging nature of these folds the Medina exposures are relatively narrow and canoe-shaped. Toward the western part of the belt of exposures of these pre-Clinton rocks, erosion has eaten deeper on the anticlinal slopes and the areas of exposure of the anticlines are much widened. In the case of the most western fold in this belt erosion has continued through the Medina Sandstones and has eaten out a valley about two miles broad with Martinsburg Shale and older limestones beneath. (Plate XXVIII). The western limb of this great anticline is nearly vertical for practically the entire length of outcrop across the county (Plates XXI, XXIV, XXVI, XXVII, and XXVIII). Westward from this line of steeply inclined

rocks the dip rapidly decreases into the broad syncline of Spruce Mountain (Plate XXVIII).

WHITE MEDINA (TUSCARORA).

Map Symbol, Swm.

Areal Distribution.—There are eight narrow belts of outcrop of the White Medina in the eleven-mile zone above referred to. The most eastern of these is a canoe-shaped anticline, beginning five miles south of Franklin at Dahmer and continuing in a northeasterly direction for ten and one-half miles, where the plunge of the anticlinal axis carries the White Medina beneath the Clinton. Three miles south from the northern terminus of this White Medina exposure, the arch is cut by deep erosion and the Red Medina is exposed in the center of the arch along the Franklin-Harrisonburg highway, just east of Hardscrabble Church (Figure 10). The central portion of this arch is known as Long Ridge. About 3 miles from the south end of Long Ridge where Props Run and the highway cross the anticlinal ridge, the ridge is a double anticlinal fold (Figure 12). The width of outcrop of this belt is between one-fourth and one-half mile.

The second line of White Medina (Tuscarora) outcrop is along an anticlinal fold about a mile west of the anticline just referred to, and beginning about a mile southwest of its northern terminus, or about two miles a little east of north of Hardscrabble Church. This line of exposures has a length of a little more than six miles and there are in this distance four isolated outcrops, two of which are very small and one at Deer Run School about two and one-half miles in length and about one-fourth mile in width.

The third line of White Medina outcrop is along Jack Mountain Anticline. This anticlinal mountain enters Pendleton County from Highland County, Virginia, on the south. This arch exposes the White Medina for a distance of a little over seven miles northeast of the county line. On the Virginia line the width of outcrop of the White Medina is a little over one-half mile. The outcrop width narrows gradually toward the northeast with the decrease in elevation of the anticlinal

axis. The Medina arch of Jack Mountain in Pendleton County has in no place been completely sectioned by erosion.

About one mile to the west of the northern portion of Jack Mountain a canoe-shaped anticline exposes a strip of White Medina four and a quarter miles long with a maximum width of one-half mile. This constitutes the fourth line of White Medina outcrops. Due to erosion across this anticline there are four small areas in this arch where the White Medina has been completely eaten through and the older rocks below exposed.

The fifth, sixth, and seventh general lines of exposures of the White Medina Sandstone in the southern portion of the county are branches from the same great anticlinal fold.

Brushy Mountain along the Highland-Pendleton County line represents the eastern limb of the great Wills Mountain Anticline. This eastern limb of the large anticline farther north in the county is represented by North Fork Mountain. From the Brushy Mountain-North Fork Anticlinal limb two secondary anticlines are given off, the eastern of these two, or the fifth line of White Medina outcrop, extends along Simmons Mountain and Bobs Mountain northeastwardly for eight and one-half miles. This fold is cut by erosion in three places sufficiently deep to expose rocks beneath the White Medina (Tuscarora) (Figure 9).

The second of the offshoot folds from North Fork Mountain, or the sixth line of outcrop of the White Medina, occupies the crest of Ruleman Mountain, Castle Mountain, and Peters Mountain for a distance of ten miles. For much of this distance the outcrop width of the White Medina is less than one-fourth mile. Where the Franklin-Circleville road passes through this arch along Friends Run, the erosion has widened the outcrop as well as exposed the Red Medina. Through most of its course this arch is faulted along its western limb. (See Figure 13). Although the White Medina outcrop plunges beneath the Clinton on Peters Mountain, about four and one-half miles northwest of Franklin, the same anticline continues toward the Grant County line along Big Mountain and Cave Mountain; just before reaching the Grant County line the anticline swings into the lowlands of the South Branch

PLATE XII.—A view from the top of Seneca Rock east along the rocks. (Photo. by W. Va. Photo Co.).

PLATE XIII.—View from back of Seneca Rock looking west. Fore Knobs can be seen through the gap on the left. (Photo. by W. Va. Photo Co.).

PLATE XIV.—A view of what is known locally as the Cathedral Arch of the Seneca Rocks. (Photo. by W. Va. Photo Co.).

PLATE XV.—The limestone valley lying east of Seneca Rock and west of North Fork Mountain. (Photo. by W. Va. Photo Co.).

of the Potomac east of Ketterman. The northern three-fourths mile of this anticline in Pendleton County is sufficiently eroded to expose the crest of the White Medina.

The seventh line of White Medina outcrops is the east limb of North Fork Mountain. This is a continuous line from Highland County on the southwest to Grant County on the northeast. Due to the height of North Fork Mountain the White Medina has a wide outcrop wherever the dip of this sandstone is small, but a narrow outcrop where the dip is steep. We thus have toward the southwest and toward the northeast in this line wide outcrops. Where streams have trenched the mountainsides, cuts are frequently completely through the White Medina into the Red Medina.

The eighth line of outcrop of the White Medina is formed by the western limb of Wills Mountain Anticline. Due to the steep inclination of the rock in this limb the White Medina has a very narrow outcrop. In many places the White Medina stands on edge and forms a very high and jagged wall, adding greatly to the picturesqueness of the scenery. (See Plates XXI, XXIV, XXVI, and XXVII, and Figures 8, 11, 14, 17, and 18).

Besides the eight lines of outcrop, there is one small isolated area of White Medina exposure, a narrow strip about two miles long and about an eighth of a mile wide, which lies between lines five and six and southeast of Castle Mountain.

Figure 5, page 68, prepared by Paul H. Price, shows the various areas of Pendleton County in which the Medina Sandstones occur at outcrop. The areas appear in greater detail on Map II accompanying this Report in a separate Atlas.

General Character.—The White Medina differs little in its general character throughout the area of its outcrop in Pendleton County. It is everywhere a ridge-forming sandstone of nearly pure white color, made up almost entirely of water-worn quartz sand. Some of the beds are made of nearly spherical coarse grains with an average diameter of nearly 1 mm.; such beds are usually cross-bedded and porous. As a general rule the sands are finer (1/3 to 1/2 mm.) and closely cemented with silica. Some of the beds with finer textured sand grains and siliceous cement have conchoidal fracture and

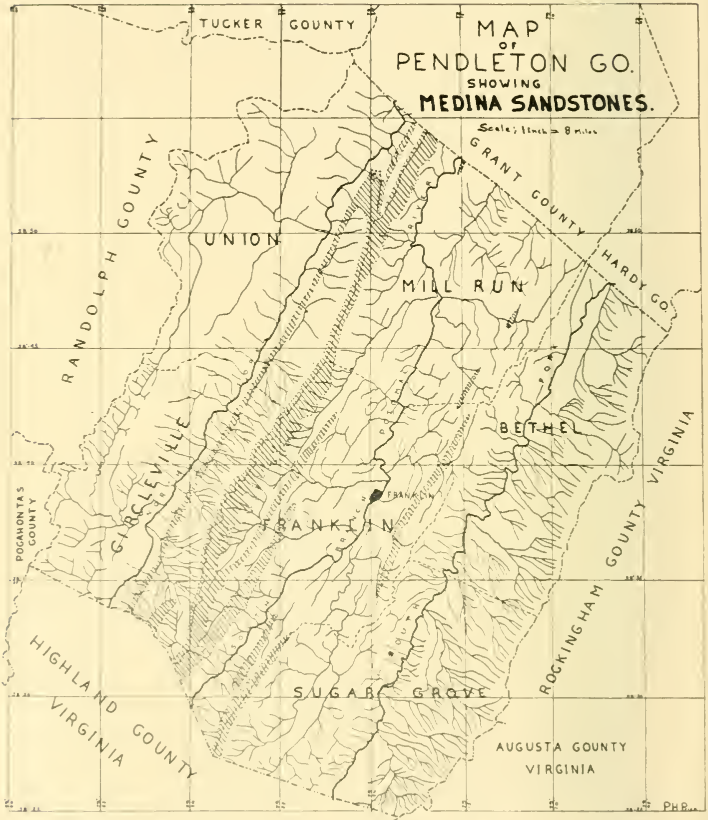

Figure 5.—Map of Pendleton County showing Medina Sandstones.

saccharoidal texture. Much of the sandstone should rightly be called a quartzite. In some localities toward its base it carries beds of light-red sandstone, although this bottom color line is usually fairly sharp.

The middle portion of the White Medina is more massively bedded than the lower and upper portions. It is this central portion which forms the great wall rocks, so beautifully exposed along the western limb of the Wills Mountain Anticline through Mouth of Seneca, Riverton, Circleville, and Hardscrabble Church.

In its extreme upper portion the thin-bedded sandstones locally have arenaceous shale partings.

Thickness.—The White Medina varies considerably in thickness in its different exposures in the county. It seems to average thicker toward the east. At Hardscrabble Church, a little northeast of Franklin, the White Medina has a thickness of 310 feet. In Castle Mountain, between Franklin and Circleville, it is 225 feet thick. Along the west limb of the Wills Mountain Anticline in west central Pendleton County it is not far from 150 feet thick. Different measurements in this area give thicknesses as follows: at Riverton 160 feet, at Circleville 170 feet, at Noah Teter Hollow 110 feet. Differences in thickness are due to two causes: difference in original bedding and difference in amount of erosion of upper White Medina before Clinton deposition. There seems to be less unconformity toward the east where the White Medina is thicker and where the Clinton is better represented.

Contacts.—There seems to be an unconformity between the Clinton and the White Medina in all the sections visited. This unconformity is seemingly less toward the east than toward the west part of the county. In the Wills Mountain Anticlinal area the Iron Sandstone is usually in contact with the White Medina. The Iron Sandstone horizon of the Clinton is well above the base of the formation.

In some sections the White Medina seems to grade into the Red Medina below, through the introduction of red sandstone beds in the lower part of the White Medina. There is no known unconformity and on this account, together with

the local color transition the Red Medina is considered of Silurian age.

Economic Character.—The White Medina is in many places a close-textured quartzite which could be used for abrasive or filler purposes or for low refractory material. In places the White Medina is both low in iron content and rather friable so that it might be used as a glass-sand.

RED MEDINA.

(Map Symbol, Srm).

General Distribution.—The Red Medina has its most continuous exposures along the great Wills Mountain Anticline in the west central portion of the county. Along the western limb of this anticline the Red Medina has an almost continuous outcrop from Highland County, Virginia, on the southwest, to Grant County on the northeast. Along North Fork Mountain, on the eastern limb of the Wills Mountain Anticline. there is not only a continuous outcrop from Highland to Grant County but there are many patches of Red Medina exposed by erosion through the White Medina in areas of its more gentle slope. Castle Mountain Anticline has one exposure of Red Medina where the Franklin-Circleville highway crosses it (Figure 13). Simmons and Bobs Mountain Anticline has three small outcrop areas of the Red Medina in places where it is cut by Hammer Run, Moyer Run, and Smith Creek, respectively. The anticlinal fold just west of Jack Mountain has four small areas of outcrop of the Red Medina in places where this arch is cut by tributaries of the South Branch of the Potomac. The anticline occupying Long Ridge, a little east of Franklin, is cut by Trout Run just to the east of Hardscrabble Church and the Red Medina exposed (Figure 10). Two other exposures in the county are known, both in the southern part—one where East Dry Run cuts Brushy Mountain, (Figure 9), and the other on the crest of Snowy Mountain.

General Character.—The Red Medina is composed largely of red sandstones and shales with occasional beds of gray

sandstone. In some sections the red arenaceous shales make up as much as fifty per cent. of the formation. In all the localities in the county in which the Red Medina is well exposed beds of gray sandstone occur similar to those composing the Gray Medina. These gray sandstone beds occur more commonly in the middle and lower portions. In a number of sections very heavy and resistant gray sandstone beds in the upper-middle portion, together with some heavy beds of red sandstone, make ridges and knobs which parallel those formed by the White Medina on the one side and the lower Gray Medina on the other (Figures 10, 13, 14, and 17). Throughout the Red Medina the argillaceous layers are always of red color. Both arenaceous shale and sandstone beds vary in thickness from a few inches to as much as, but usually not more than, ten feet.

Without exception the Red sandstones are less resistant to weathering than the Gray and White sandstones. This is due to the more argillaceous character of their cement.

Thickness.—The Red Medina has a thickness in all sections studied much greater than the combined thickness of both White and Gray Medinas. The most reliable measurements of the thickness of the Red Medina are in the western exposures where the Gray Medina and older rocks are turned on edge along the western limb of Wills Mountain Anticline. The greatest thickness measured is at Riverton where the Red Medina is 650 feet. At Circleville six miles to the south it is 550 feet, and at Noah Teter Hollow, one mile south of Circleville, it has a thickness of only 350 feet. It is possible that there is a loss of strata in this last-mentioned locality through reverse faulting. Along the new graded road over North Fork Mountain to the northeast of Circleville the measured thickness is 550 feet, but here also faulting may have caused repetition or loss of part of its thickness. The section through the Red Medina in Castle Mountain Anticline is not a complete one, as is also the case in the section along the Franklin-Harrisonburg road at Hardscrabble Church east of Franklin. The thickness of the portion exposed in these two sections is 300 feet and 375 feet, respectively.

Contacts.—The contact with the White Medina has

already been discussed. The gray sandstone beds in the Red Medina are identical in character to those in the Gray Medina. The line between the formations has been drawn where the red shale partings cease. After a careful study of those formations I am of opinion that they belong to the same period and I am therefore including the Gray Medina in the Silurian rather than the Ordovician. I have on several occasions mistaken some of the more massive beds of gray sandstone in the Red Medina for the Gray Medina.

Economic Character.—As far as known the Red Medina has practically no commercial value.

GRAY MEDINA.

(Map Symbol, Sgm).

Distribution.—The outcrop of the Gray Medina in Pendleton County is confined to the area of the Wills Mountain Anticline. There is a continuous outcrop of the Gray Medina from the Highland County, Virginia, line along the west limb of the anticline to about two miles a little east of north of Mouth of Seneca. Here the offset in the structure, as well as the smaller amount of erosion in the center of the anticline, causes the outcrop of the Gray Medina to turn back southwestwardly along the eastern limb of the anticline. Its outcrop along the eastern limb is also unbroken from the Mouth of Seneca region to the Virginia line in Highland County.

About two miles northeast from Mouth of Seneca the offset Wills Mountain Anticline is deeply enough eroded to expose the Gray Medina. From this place to the Grant County line, about five miles distant, the Gray Medina is exposed on both limbs of the anticline.

The Gray Medina Sandstone caps the Snowy Mountain which rises out of the Wills Mountain anticlinal valley along the Highland County, Virginia, line. About three miles southeast of the Snowy Mountain, a minor anticlinal arch brings up the Gray Medina.

Character.—The Gray Medina (Plates XVI and XVIII) is usually a rather fine-textured gray to slightly brownish

sandstone, with bedding-planes from a foot to four or five feet thick. In some places the weathered sandstone shows small brown spots of iron oxide on freshly broken face of the stone. This gray sandstone resembles considerably the unweathered top sandstones of the Martinsburg, but after weathering the two are very different, the Martinsburg sandstone becoming dark-brown in color and full of holes from the weathering of fossils, while the Medina is gray and non-fossiliferous.

Thickness.—The thickness of the Gray Medina varies from about seventy to one hundred and twenty-five feet in the various outcrops in the county. Three carefully measured sections were made. At Circleville the thickness is 106 feet, at Riverton 70 feet, and at Noah Teter Hollow it is 103 feet. Farther southwest toward the Virginia State line the thickness of the Gray Medina seems to increase to about 125 feet.

Contacts.—In character the sandstones of the Gray Medina are indistinguishable from the gray sandstones in the Red Medina above. The line between the Red Medina and the Gray Medina is drawn where the red shales cease. The two formations in all exposures seem to have parallel bedding with no erosional unconformity more than is common in contemporaneous erosion. From the above facts, I am led to the conviction that the Gray Medina belongs in the same period as the Red Medina.

In the weathered rocks the break between the Gray Medina and the Martinsburg is apparent, but in the unweathered rocks the color differences can not be relied upon and the line must be drawn at the top of the fossiliferous beds of the Lingula nicklesi zone. Throughout the area of the county wherever the contact between the Martinsburg and the Gray Medina has been studied there is little or no divergence in dip or strike of the beds. The Lingula zone seems to be everywhere present and of about the same thickness. The most apparent break between the two formations is in the fossiliferous character of the Martinsburg and the non-fossiliferous character of the Gray Medina.

Economic Character.—If the Gray Medina sandstones were located near centers of great population they might be

utilized for building stone, since they resist weathering to an unusual degree and are also of pleasing color. These stones like the White Medina would make most excellent material for road foundations and for concrete mixtures.

MARTINSBURG SHALE.

(Map Symbol, Oms).

Areal Distribution.—The outcrop of the Martinsburg Shale is confined to a broad anticlinal area, running entirely across the west-central portion of the county. This belt on the southwest along the Virginia line has a breadth of a little over three miles, and on the northeast along the Grant County line it has a width of about a mile. The belt is a continuous one with the exception of a narrow strip about five miles southwest of the Grant County line and two miles northeast of Seneca Rock. At this locality a narrow strip of Medina sandstone still arches from the eastern to the western limb of the great anticline and divides the narrower and the shorter Martinsburg valley toward the northeast from the broader and longer valley toward the southwest.

A belt of Ordovician rocks older than the Martinsburg is brought to the surface of the anticlinal valley for a distance of about seven miles or about from Harper Gap southwestwardly to within about two miles of Judy Gap. Also along the Virginia line, the Martinsburg outcrop is broken by a narrow strip of Medina which caps Snowy Mountain.

In addition to the broad belt of Martinsburg above described there is a small elliptical area of this shale, about one-fourth mile broad by three-fourths mile long, exposed where East Dry Run cuts the Brushy Mountain—Simmons Mountain Anticline (Figure 9). This is in reality a minor fold on the east flank of the great Wills Mountain Anticline.

The Martinsburg has, all told, about thirty-nine square miles of outcrop in the county.

Figure 6, page 75, prepared by Paul H. Price, shows the various areas of Pendleton County in which the Ordovi-

cian Rocks appear at the surface. These areas are shown in greater detail on Map II accompanying this Report in a separate Atlas:

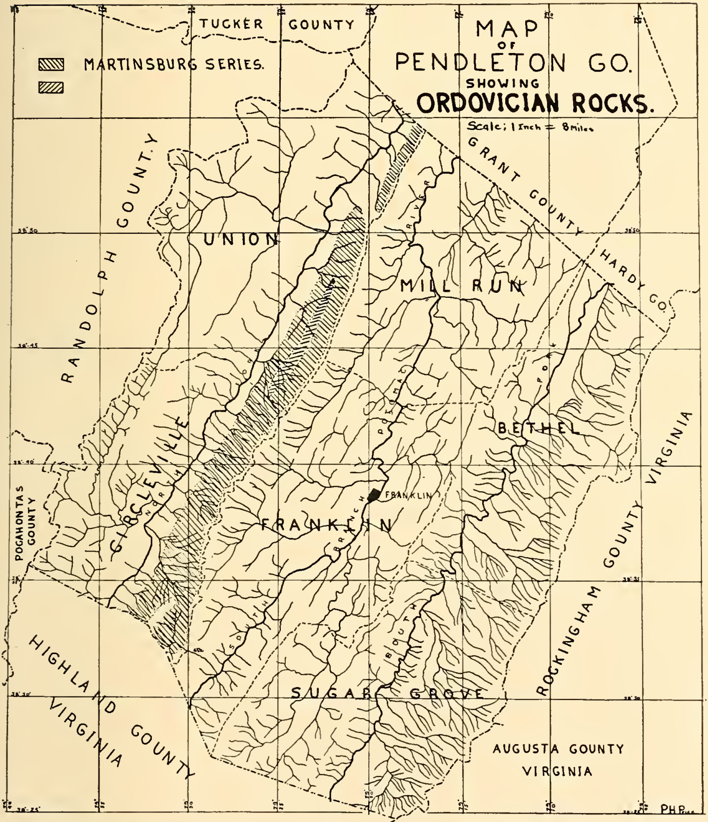

Figure 6.—Map of Pendleton County showing Ordovician Rocks.

Character.—The Martinsburg is everywhere a highly calcareous formation. The upper portion is more largely

argillaceous and sandy than the middle and lower portions, but even the sandstones give evidence of having been calcareous before weathering.

In the middle portion occur yellowish-weathering shales with thin sandstone beds and occasional limestone lenses and reefs (Figure 16). Toward the base the percentage of limestone increases, and the character changes from the highly crystalline, rather bluish to gray lenses, to the more compact, earthly, and darker-colored thick limestone beds. Some of this latter type is marked by a concretionary lensic development of the limestone in a highly calcareous shale or impure limestone matrix (described as a cobbly limestone) (Plate XIX). In some parts of the formation the more compact limestone lenses which occur in the shales have been fractured by earth movements and later recemented by light-colored calcite.

A few partial sections of the Martinsburg, given elsewhere in this Report, show more detail as to the general character of the formation (Figures 15 and 18, and Plates XVIII, XIX, XXIII, and XXVI).

Thickness.—The maximum thickness of the Martinsburg has not been exactly determined, because of lack of continuous exposures through its entire thickness or because of faulting with unknown throw. A measured section (Figure 15) east of Circleville gives a thickness of 1800 feet from the top well down into the Trenton portion of the Martinsburg. A section along the new graded Franklin-Circleville road, from the top of the formation through the cobbly limestone beds of the Trenton, shows a thickness of 2300 feet (Figure 16). A rough section made along the old road over North Fork Mountain and across Wills Mountain anticlinal valley gives an estimated thickness of the Martinsburg as 2300 feet on the east limb, and about 2000 feet on the west limb (Figure 17).

Divisions.—The Martinsburg has three well-recognized divisions: The upper or Maysville, which is more or less sandy, the Eden, which is largely a shale, and the upper Trenton, more largely a limestone.

The Maysville, throughout the area of outcrop in the county, is at top a heavy-bedded, rather resistant, ferruginous

sandstone, carrying abundant fossils. An upper zone in this sandstone has many Lingula nicklesi Bassler, and below this Orthorhynchula linneyi (James) occur in great abundance. This latter fossil indeed is found throughout the red sandstone phase while the Lingula is seemingly confined to the upper portion. On account of the great development of the Lingula in this upper part of the red sandstone this has been called by several authors the Lingula nicklesi Zone, while the more abundant occurrence of the Orthorhynchula below the Lingula Zone has given rise to the designation of this horizon as the Orthorhynchula Zone. Beneath the ferruginous sandstone, sandy beds in shale continue for some thickness. These carry an abundant fauna, one of the most conspicuous fossils being Rafinesquina alternata.

The Eden is more shaly and has Plectambonites sericeus variety in great abundance, also Dalmanella multisecta, Zygospira recurvirostris, and Hormotoma gracilis, Calymene sp., and Orthoceras transversum.

The Trenton division of the Martinsburg has in most exposures a very abundant fauna. Some of the more abundant forms are: Praspora simulatrix, Cryptolithus tesselatus, Isotelus gigas, Pholidops sp., Sinuites cancellatus, Dalmanella testudinaria. The Cryptolithus tesselatus occurs here in greatest abundance toward the base of the Trenton division.

East of Circleville a fairly good section of the Martinsburg is to be seen. Here the Maysville has a thickness of about 300 feet, the Eden of about 800 feet, and the Trenton as far as exposed of about 650 feet.

Contacts.—The contact between the Martinsburg and the Gray Medina was studied in a number of places and with considerable care in two localities. In both places where the contact was most carefully studied the contact beds are parallel and the unconformity is demonstrated only by the more highly ferruginous coloring of the weathered Martinsburg and its fossiliferous character in contrast to the non-fossiliferous and resistant gray-weathering character of the Gray Medina Sandstone beds.

The contact of the Martinsburg with the underlying Chambersburg is not well-defined lithologically, because of the

lack of good exposures and the similarity of coloring of the two formations. The line between the two formations is drawn largely on a basis of faunal difference, but also, in part, on the slightly more massive character of the Chambersburg Limestone.

Economic Character.—The lower portion of the Martinsburg in the Trenton division is largely a limestone. The rocks of this portion could be well utilized in the manufacture of Portland cement.

CHAMBERSBURG LIMESTONE.

(Map Symbol, Ocb).

General Character.—The Chambersburg Formation is for the most part composed of pure to argillaceous limestones of a dark-gray to blue color. The upper portion is rather thin-bedded dark-gray to blue fine-textured limestone with some calcareous shale partings. Below these beds come in somewhat darker bluish to gray semicrystalline limestones. These are followed by dark-gray compact rather impure limestones, in places rather cobbly. Below this occur coarser-textured, dark-gray to nearly black, highly petroliferous limestones.

Outcrop.—The outcrop of the Chambersburg is limited to one small canoe-shaped area in the erosional valley of Wills Mountain Anticline. This area has a maximum length of seven miles and a maximum width of a little over one mile. This northern limit of outcrop is about one mile a little south of east of Harper Gap, and the southern limit is a little north of Hopewell School or about one and one-half miles north-east of Judy Gap. The outcrop area is largely in the so-called Germany Settlement, and includes Key, Judy or McDonald Spring, and Cave School.

Thickness.—On account of the numerous planes of low-angle faulting which cut the limestone underlying the Martinsburg in this whole district (See Figure 7), it is practically impossible to get very accurate measurements of the thickness of the Chambersburg but sections made in the neighborhood

of Key and to the east of Key seem to show a thickness of between three and four hundred feet.

Faunal Character.—The Chambersburg is very fossiliferous. Weathered surfaces of many of the limestones show numerous species of bryozoa, gastropods, ostracods, and coral; some brachiopods and cystids; many crinoid stems, and a few other fossils. Due to the extensive faulting no attempt has been made to separate and describe faunal zones in the Chambersburg except to recognize the greater abundance of fossils in the middle and upper portions. The following species have been recognized from the Chambersburg:

Rafinesquina cf. minnesotensis Winchell
Echinosphaerites aurantium var. americanum Bassler
Orbignyella wetherbyi (Ulrich)
cf. Gonioceras chaziense Ruedemann
Helicotoma sp.
Pianodema subaequata (Conrad)
Strophomena sp.
Leperditia fabulites Conrad
Zygospira recurvirostris Hall
Crinoid stem
Orthoceras sp. (1½ in. in diameter)
Solenopora compacta Billings
Plectambonites pisum Ruedemann
Camarotoechia sp., cf. plena Hall
cf. Chasmotopora
Ramose bryozoa sp.
Girvanella sp.
Elongate elliptical ostracod sp.

From the above it is evident that the Echinosphaerites beds, the Tetradium cellulosum beds, and the Caryocystites beds at least are represented in the exposures of Chambersburg at this locality.

Economic Character.—Most of the Chambersburg is limestone and some of it very pure limestone suitable for lime burning or cement manufacture.

STONES RIVER LIMESTONE.

(Map Symbol, Osr).

A very pure light-gray dove-colored limestone occurs a little east of Key and for about two thousand feet up the

small branch to the east of Key. This, as far as studied, seems to have few fossils, but its massive character, its dove color, and its inclusions of many small calcite stringers and spots suggest its Stones River age.

Area of Outcrop.—These limestones are confined to a very small area in the immediate neighborhood of Key. A little south of Key these limestones have seemingly been faulted over the Chambersburg.

Economic Character.—These limestones are very pure calcium carbonate and make excellent stone for lime burning and for cement manufacture.

FAULTS.

Several low-angle fault-planes have been observed in the central portion of the great Wills Mountain anticlinal valley (Figure 7). These fault-planes occur at different levels in the valley and seem to have a slight inclination toward the east. In places, however, there is a slight west inclination. The series of planes observed at Key is the most striking (Plate XXIX). Along the fault-planes there is an accumulation of crystalline calcite, in places three feet or more thick. Many of the crystals of calcite in these deposits are more than six inches across and some are so pure and clear as to be in part classed as Iceland spar. This fault series at Key is known to extend for some distance both to the southwest and to the northeast. In a number of places secondary movements have occurred along these fault-planes, as indicated by the slickensided character of the calcite (Plate XVII), and furthermore the non-parallel character of these striations or slickensided grooves indicates movements at different times and different directions. This low-angle faulting is to be expected low in the anticline below the competent beds forming the unsymmetrical arch. In this locality the low-angle faulting has caused some of the older beds toward the center of the anticline to be carried to the westward over the younger Ordovician shales. This accounts for the narrowing of the Martinsburg outcrop in the area about Key.

TOPOGRAPHY.

The calcareous and argillaceous character of the Martinsburg allows it to be more readily weathered and carried off by streams than the Medina Sandstones which flank it in outcrop along the crests of North Fork Mountain, River Knobs, Brushy Mountain, Devils Backbone, Simmons Mountain, and Snowy Mountain. Bordering all of these ridges and mountains the Martinsburg Shale outcrops well up the slope. Due to the deep dissection of the anticlinal fold, the slope from the high lands into the bottom lands is steep. All public roads crossing the mountains zigzag with many hairpin curves to keep the gradient to six per cent. Practically all minor elevations in the Martinsburg area are modified and steeply rolling. Much of the land is too steep for cultivation and is given over to grazing. Luxuriant blue-grass usually covers the areas not occupied by chestnut trees and prevents excessive erosion.

The purer limestones of the Chambersburg and Stones River offer opportunity for underground waters to do much work in solution. Sinks are common in both these formations. In the Germany Settlement area these sinks are unusually common, due to the numerous and extensive low-angle fracture planes which permit easy percolation of underground waters. Judy Spring (McDonald Spring) marks the position of lowest topography in this relatively pure limestone valley where the underground waters emerge laden with lime in solution.

An interesting effect of attitude of the Medina Sandstones upon the height of the ridge in which it occurs is well illustrated in the east and west limbs of Wills Mountain Anticline. The eastern limb has a dip of about 30 to 40 degrees and rises to an average elevation of about 4000 feet. The western limb has a vertical dip and an average elevation of about 3000 feet.

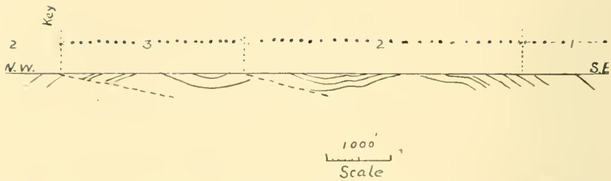

Figure 7.—Section through central portion of Wills Mountain Anticline showing the older limestones and the low-angle faults cutting them. This section was made in the neighborhood of Key, northern portion of Germany Settlement.

1 Martinsburg.
2 Chambersburg.
3 Stones River.

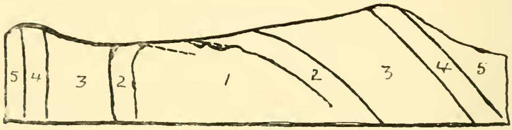

Figure 8.—Typical cross-section through Wills Mountain Anticline, not drawn to scale, but representing approximate conditions in the north Germany Settlement area.

1 Stones River and older Limestones.
2 Chambersburg Limestone.
3 Martinsburg Shale.
4 Medina Sandstones.
5 Clinton Shale and Sandstone.

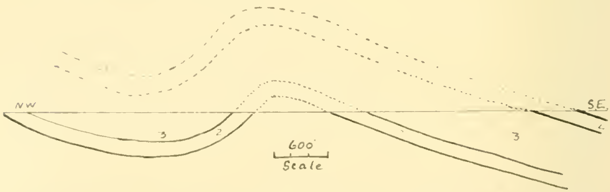

Figure 9.—Section through gap between Simmons Mountain and Brushy Mountain. The west end of the section shows the Martinsburg Shale coming to the surface in the anticlinal valley of Wills Mountain Anticline. The small anticline in the center of the section forms to the southwest the anticlinal ridge of Brushy Mountain, and to the northeast the anticlinal ridge of Simmons Mountain. This minor anticline is an offshoot from the great Wills Mountain Anticline.

1 Martinsburg.
2 Gray Medina.
3 Red Medina.
4 White Medina

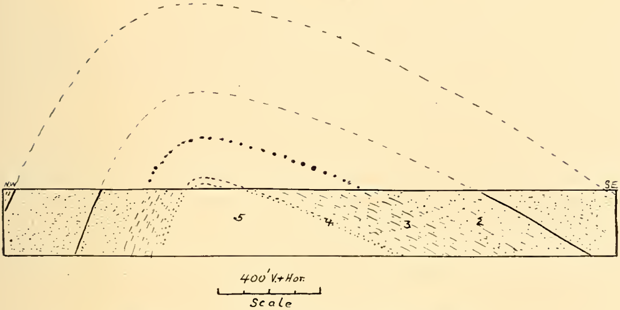

Figure 10.—Hardscrabble Church Section.

1 White Medina.
2 Red Medina, largely red sandstone.
3 Red Medina red shales and sandstones, more shale than sandstone.
4 Gray sandstone in Red Medina.
5 Concealed Red Medina.

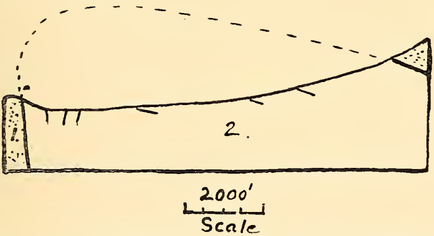

Figure 11.—Profile section through Wills Mountain Anticline along old Franklin-Circleville road.

1 Medina Sandstone.
2 Martinsburg Shale.

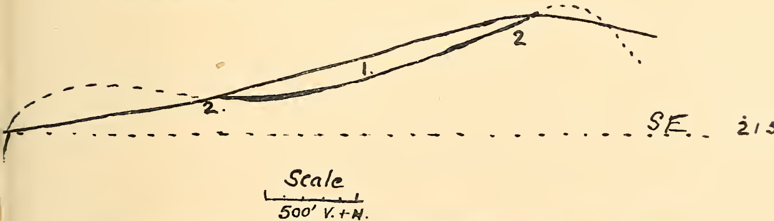

Figure 12.—Profile section through Medina-Clinton ridge, Props Run road, 2 miles southeast of Franklin.

1 Clinton.
2 Medina.

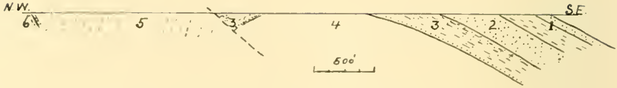

Figure 13.—Section through Castle Mountain.

1 Clinton.
2 White Medina.
3 Red Medina, gray sandstone near base.
4 Concealed, upper part Medina.
5 Concealed, probably Niagara near the fault and Rondout away from it.
6 Bossardville outcrop.

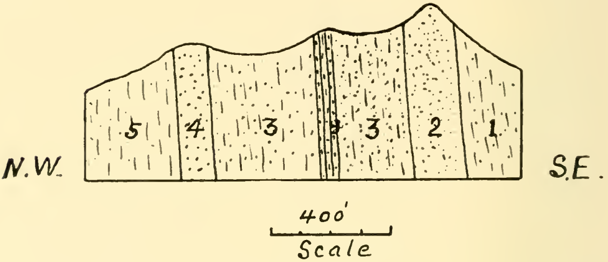

Figure 14.—Typical profile through the Medina sandstones and the bordering shales.

1 Clinton.
2 White Medina.
3 Red Medina, with heavy gray sandstone bed a little above center.
4 Gray Medina.
5 Martinsburg.

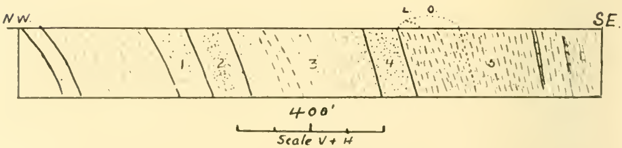

Figure 15.—Cross-section through a portion of Noah Teter Hollow.

1 Red Sandstone of the Clinton.
2 White Medina.
3 Red Medina.
4 Gray Medina.
5 Martinsburg, with { L Lingula zone. / O Orthorhynchula zone.

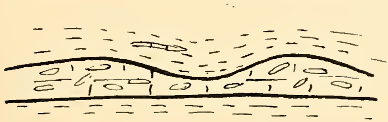

Figure 16.—Typical limestone lens or reef in shales of the lower portion of the Eden division of the Martinsburg. These are usually highly crystaliine and frequently inclose fragments of less pure and less highly crystalline linmestone.

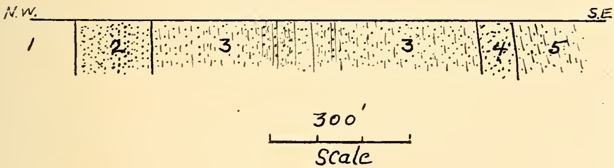

Figure 17.—Riverton Gap Section.

1 Clinton.
2 White Medina.
3 Red Medina including some gray sandstone beds.
4 Gray Medina.
5 Martinsburg.

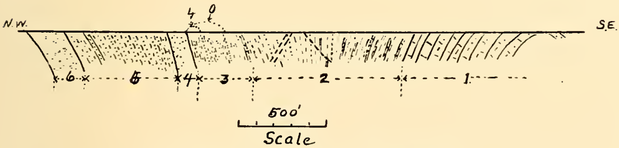

Figure 18.—Circleville Gap Section.

1 Trenton.
2 Eden.
3 Maysville. { O Orthorhynchula zone. L Lingula zone.
4 Gray Medina.
5 Red Medina, including some gray sandstone beds.
6 White Medina.

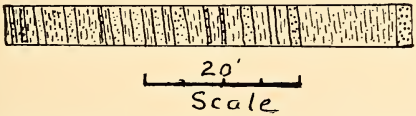

Figure 19.—Typical section of portion of lower-middle Red Medina, Circleville Gap.

DESCRIPTION OF PLATES.

PLATE XVI.—Contact between Red and Gray Medina is to be seen at the right end of the board which overlies a portion of the stream in the left foreground of the picture. The rocks are here shown with an easterly dip. This is due to overturning on the west side of the great Wills Mountain Anticline. Locality, Circleville Gap.

PLATE XVII.—Low-angle fault-plane cutting the Chambersburg and Stones River Limestones in the neighborhood of Key, Germany Settlement. The photograph shows slickensides in the calcite filling along the fault-plane. These slickensides are found to trend in different directions in the different layers of the calcite, showing apparently a succession of movements in slightly different directions. This photograph shows the fault-plane to have a slight western dip, but in most places it has a low-angle eastern dip.

PLATE XVIII.—Bottom of Gray Medina and top of Martinsburg Shales. The contact between the two runs diagonally across the picture from southeast to northwest, passing under the shed in the central part of the picture. The overturned east-dipping Gray Medina is to be seen in the foreground of the picture, the lower portion of it making a small waterfall. The Lingula zone of the Martinsburg extends up the stream as far as the foot-bridge. Locality, Circleville Gap.

PLATE XIX.—Calcareous shales and hard cobbly limestone in the Prasopora zone (Trenton), Circleville Gap.

PLATE XX.—View of the White Medina Sandstone from the Franklin-Harrisonburg road near Hardscrabble Church.

PLATE XXI.—The vertical bed of White Medina in Riverton Gap. This bed represents the middle portion of the White Medina, which is everywhere through this region the most resistant part and which is the ridge-forming sandstone.

PLATE XXII.—Harmon Rocks from the new county road, northwest side of North Fork Mountain. The Rocks represent the resistant portion of the White Medina which are here fantastically outlined against the sky-line. Between the Rocks and the road in the foreground come in the Red Medina, the Gray Medina, and the upper portion of the Martinsburg.

PLATE XXIII.—Martinsburg Shale slopes, Noah Teter Hollow. Here the land is not too steep to prevent plowing and growing of crops, but in most places the slopes are so steep that it is more profitable to use the land for grazing. Chestnut trees grow naturally in this soil.

PLATE XXIV.—Side view of White Medina "wall". This picture shows the same ridge as that seen in Plate XXI. Riverton Gap.

PLATE XXV.—Harmon Rocks. View looking southeast along the strike from just north of the new county road, showing portions of White Medina and Red Medina in profile. The Red Medina comes in below the western crest of the hill (left of picture). The presence in it here of a resistant

gray sandstone is well shown by the bench in the right-hand portion of the picture. This gray sandstone bed crosses the county road just below the high point in the gap. Note the abundance of chestnut trees.

PLATE XXVI.—Noah Teter Hollow looking west. Wall of White Medina Sandstone is to be seen in left background. Contact of Gray Medina and Martinsburg forms sky-line in right-hand portion of picture. Bottom of Orthorhynchula Zone is in lower right-hand corner of picture.

PLATE XXVII.—View of Seneca Rock, looking east through Seneca Rock Gap into the valley of Wills Mountain Anticline. In the background can be seen the crest of North Fork Mountain which is capped by the Medina Sandstone, the same formation as that of Seneca Rock. These two ridges represent opposite limbs of the same fold and are over two miles apart. View taken from highway a little south of Mouth of Seneca.

PLATE XXVIII.—Panoramic view through 180 degrees from northeast through northwest to southwest, taken from new county road on west side near crest of North Fork Mountain. Between North Fork Mountain and the first range of hills to the northwest is the Wills Mountain anticlinal valley. This valley toward the southwest (left) is composed entirely of Martinsburg Shale, but toward the north the older limestones beneath the Martinsburg come back to the surface. The first ridge to the northwest is the "River Knobs" formed by vertical Medina Sandstone in west limb of Wills Mountain Anticline. The next range of hills to the northwest is held up by the less steeply dipping Oriskany Sandstone, and the high ridge in the background is held up by Carboniferous sandstone in the center of the great Stony River Syncline. In the first ridge toward the southwest the vertical wall of White Medina Sandstone can be readily seen in Riverton Gap.

PLATE XXIX.—View of low-angle fault with three-foot calcite bed along the fault-plane. About 200 feet southeast of Key. This fault continues for at least two miles along the strike, in this area. Waters from the overlying limestones have percolated along this fault in the past and precipitated the thick bed of calcite. In many places in the overlying limestones, caverns and sinks are to be found. The sink shown in Plate XXX is about 250 feet from this locality and in the overlying Stones River Limestone.

PLATE XXX.—A small sink in the bed of a now dry branch about 450 feet southeast of Key, and about 250 feet southeast of the fault shown in Plate XXIX. The water from this sink evidently finds an outlet along the fault-plane shown in Plate XXIX. Many such passages probably lead to the great spring a little to the north of here (Judy Spring or McDonald Spring).

PLATE XXXI.—Mushroom or pedestal rock found about 4,000 feet southeast from Key up the branch and just below the point where the branch crosses the road leading down the mountain into Germany Settlement. This rock is made of petroliferous Chambersburg Limestone.

PLATE XVI.—Contact between Red and Gray Medina, Circleville Gap. (See page 86 for further description of Plate). (Photo. by Wm. F. Prouty).

PLATE XVII.—Low-angle fault-plane cutting the Chambersburg and Stones River Limestones in the neighborhood of Key, Germany Settlement. (See page 86 for further description of Plate). (Photo. by Wm. F. Prouty).

PLATE XVIII.—Bottom of Gray Medina and top of Martinsburg Shales, Circleville Gap. (See page 86 for further description of Plate). (Photo. by Wm. F. Prouty).

PLATE XIX.—Calcareous shales and hard cobbly limestone in the Prasopora zone (Trenton), Circleville Gap. (Photo. by Wm. F. Prouty).

PLATE XX.—View of the White Medina Sandstone from the Franklin-Harrisonburg road near Hardscrabble Church. (Photo. by Wm. F. Prouty).

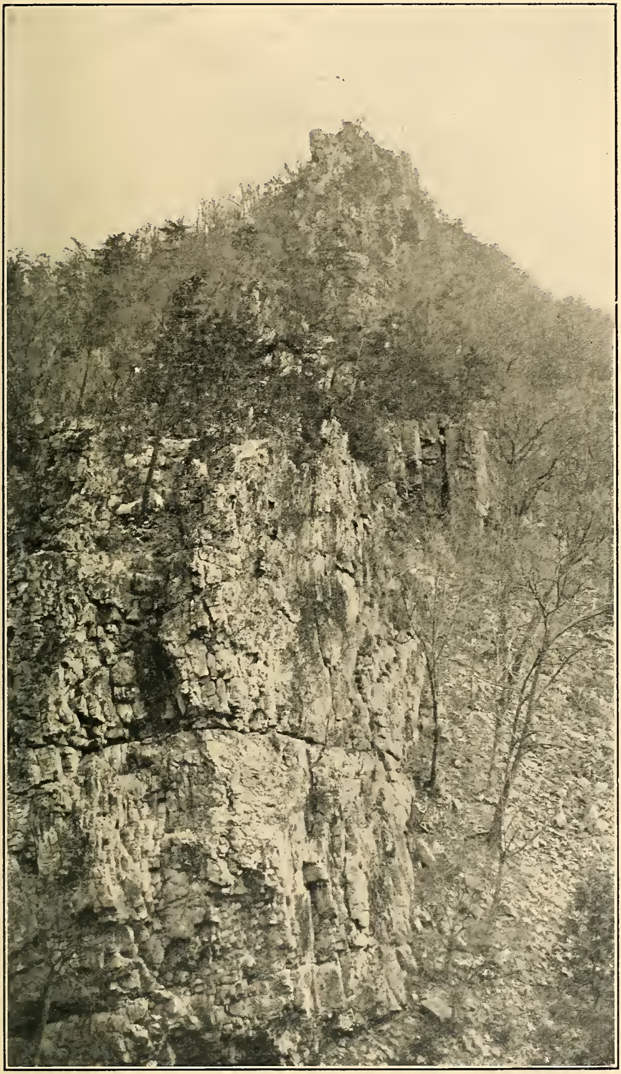

PLATE XXI.—The vertical bed of White Medina at Riverton Gap. (See page 86 for further description of Plate). (Photo. by Wm. F. Prouty).

PLATE XXII.—Harmon Rocks from the new county road, northwest side of North Fork Mountain. (See page 86 for further description of Plate). (Photo. by Wm. F. Prouty).

PLATE XXIII.—Martinsburg Shale slopes, Noah Teter Hollow. (See page 86 for further description of Plate) (Photo by Wm. F. Prouty).

PLATE XXIV.—Side view of White Medina "wall", Riverton Gap. This picture shows the same ridge as that seen in Plate XXI. (Photo. by Wm. F. Prouty).

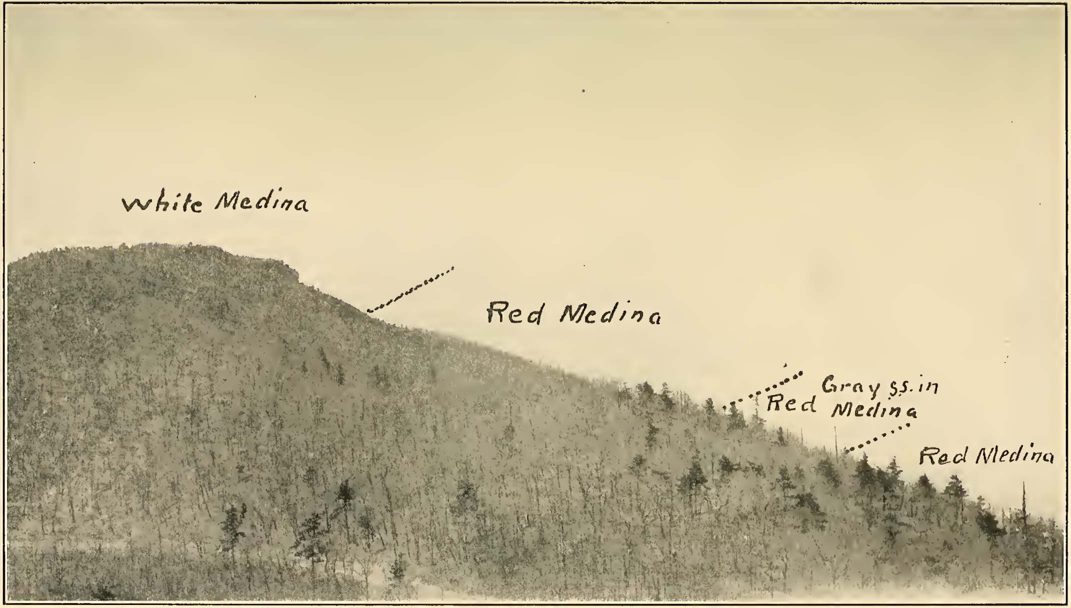

PLATE XXV.—Harmon Rocks, looking southwest along the strike from just north of the new county road, showing portions of White Medina and Red Medina in profile. (See page 86 for further description of Plate). (Photo. by Wm. F. Prouty).

PLATE XXVI.—Noah Teter Hollow, looking west. Wall of White Medina Sandstone is to be seen in left background. (See page 87 for further description of plate.) (Photo. by Wm. F. Prouty).

PLATE XXVII.—View of Seneca Rock, looking east through Seneca Rock Gap into the valley of Wills Mountain Anticline. (See page 87 for further description of plate). (Photo. by Wm. F. Prouty).

PLATE XXVIII.—Panoramic view through 180 degrees from northeast through northwest to southwest, taken from new county road on west side near the crest of North Fork Mountain. (Right-hand edge of top fits at left-hand edge of center view, while right-hand edge of center fits left-hand edge of bottom view). (See page 87 for further description of Plate). (Photo. by West Virginia Photo. Co., Thomas, W. Va.)

PLATE XXIX.—View of low-angle fault with three-foot calcite bed along the fault-plane, about 200 feet southeast of Key. (See page 87 for further description of Plate). (Photo. by Wm. F. Prouty).

PLATE XXX.—A small sink in the bed of a now dry branch about 450 feet southeast of Key, and about 250 feet southeast of the fault shown in Plate XXIX. (See page 87 for further description of plate). (Photo. by Wm. F. Prouty).

PLATE XXXI.—Mushroom or pedestal rock found about 4,000 feet southeast from Key. Chambersburg Limestone. (See page 87 for further description of Plate). (Photo. by Wm. F. Prouty).

CHAPTER IV.

THE GEOLOGICAL FORMATIONS ABOVE THE TOP OF THE WHITE MEDINA.

By John L. Tilton.

INTRODUCTION.

The top of the White Medina constitutes a well-marked horizon wherever the White Medina appears. As a whole it is a mass of dense white resistant conglomeratic sandstone and quartzite. Where the folds rise high in a structure their resistant masses stand in huge rolls, or, if the crest is eroded, the remaining portions of these huge arches stand in steep ridges. Such is the position all along River Knobs where the sharp jagged edges rise like a vertical wall east of North Fork throughout the length of the county, a wall pierced here and there by deep erosional gaps through which the drainage escapes from wide valleys to the east eroded in older strata. Such gaps are at Seneca Rock, Harper Gap, Mill Creek, Judy Gap, Circleville Gap, Teter Gap, Dry Run.

West of River Knobs one stratum follows another at the surface from the oldest next the White Medina to the youngest in the mountains along the west border of the county, first in steep-sided folds, then in folds that gradually flatten out toward the west.

At River Knobs the sharp edges of the White Medina seem to rise into the air and there stop. In reality this is but the ragged edge left on the west side of an arch, the other side of which comes down as North Fork Mountain, the east side of a huge arch known from its continuation farther north as Wills Mountain Anticline. This huge arch extends north-

east-southwest across the county, widening out through the central portion of its extent, and thus dividing the county into two distinct portions, that to the west and that to the east (of North Fork Mountain), a division that will be constantly used in the following descriptions of strata.

East of this huge eroded arch the White Medina border disappears beneath later strata, but reappears here and there in the crest of lower folds. The White Medina flanks both sides of Bobs and Simmons Mountains. It forms Long Ridge, Sharp Ridge, and Jack Mountain. Even where the White Medina is deep beneath the surface its strong mass seems an important factor in determining the structure of overlying strata.

The Medina-Clinton Contact.—The uppermost rocks of the White Medina form a definite horizon from which to measure the next overlying Series of strata. The topmost bed[1] of the White Medina is a coarse massive quartzitic bed about three feet thick. This is followed immediately by the reddish-brown sandstone and shale of the Clinton Series, which thus follows the borders of the White Medina arches. The change locally with its gradation from a gravelly beach formation to a deposit of dark and brownish sandstone with oxidized material, then to a deeper ferruginous shale, is indicative of a subsidence, the overlap marking a disconformity at the contact.

THE CLINTON SERIES.

(Map Symbol, Scl).

General Section.

	Feet.
Sandstone, **Keefer Sandstone**, top of Clinton Series; reddish, dense and conglomeratic in upper and lower portions, shaly in center. This is a very persistent horizon marker to use in the search for iron which occurs in the shale below.............	10–75

[1]The uppermost beds of sandstone are called Cacapon Sandstone in the Franklin Folio of the United States Geological Survey, and the White Medina below is called Tuscarora. The upper part of the Clinton is called the Rockwood.

	Feet.
Shale, buff or greenish, iron-stained, fossiliferous; sometimes with beds of dark limestone; but limestone and iron are not at the same horizon in the different areas of shale	260
Sandstone, reddish, dense, somewhat conglomeratic	10–25
Sandstone, grayish-red, shaly	35
Sandstone, grayish-red, dense; base of the Clinton Series	140
Total	455

West of North Fork Mountain.—The above general description fits nicely for the strata at Seneca Rock, where the Clinton is slightly overturned toward the west, but so on edge that the thickness (455 feet) can be measured with a tape line. In the shale below the Keefer Sandstone a portion is concealed, but there is limestone in what is present. There is no iron visible, the most likely fragments proving to be dense reddish sandstone.

In a ravine half a mile northwest of Seneca Rock the basal member was not exposed. Above this it was dark and siliceous for 40 feet, then a reddish-brown sandstone for 35 feet, the total here assigned to the Clinton being 205 feet.

In the large ravine half a mile east of the mouth of Shafter Run the Clinton was found by pacing to be 300 feet thick.

To the south of Seneca Rock the overhang to the west becomes pronounced. Here but 90 feet of shale were found that could be classed with the Clinton, terminated by the ledge of reddish-brown sandstone (Keefer).

Just east of Circleville and farther southwest to the State line the overhang is still more pronounced. At Circleville the overhang gives a dip of 51° 20′ southeast, the Clinton thus standing with its oldest strata uppermost. Of the basal reddish sandstone only 35 feet are exposed, the remainder being concealed or pinched out in the overturn. Above the sandstone (in the true stratigraphic order) is a two-foot ledge of limestone. Next above this is a 25-foot bed of reddish sandstone, followed by 210 feet of arenaceous limestone rather than buff shale, fossiliferous in places but with no iron ore.

At the top is the customary grayish-red Keefer Sandstone. This entire series is squeezed into a space of 272 feet.

At Dry Run 50 feet of the lowest portion of the Clinton are exposed, following which 75 feet are concealed to the grayish-red Keefer Sandstone, which is here unusually thin.

No iron ore has been seen on the west side of River Ridge, though sandstone is deeply stained and heavy with iron.

Toward the west the Clinton disappears beneath the later formations and does not reappear within the limits of the county.

East of North Fork Mountain.—On the eastern slope of North Fork Mountain the dip is not so steep as on the west side near North Fork, and the Clinton lies high along the eastern slope of the mountain, always dipping southeast in that region. Where the road from Ruddle to Mill Creek and Harper Gap approaches the divide it lies along the Clinton for a mile, crossing the area of Clinton strata diagonally, leaving it at the divide. East of this area there is a region from a mile and a quarter to a mile and a half west of Ruddle where there is an anticline in which the Clinton again appears.

On the west side of Castle and Peters Mountains at the syncline between the two White Medina areas the road lies along the Clinton diagonally for a mile. Along the new road north toward Harmon Rocks the road is on the Clinton all the way to about a mile from the divide, where it enters the area of White Medina and continues in it to the divide. From 2.5 miles northeast of Friends Run to 2.5 miles southwest of Goshen School, the Clinton ends against a fault-plane that lies along the west side of the narrow Medina area to the east. The Clinton is well exposed for 0.8 mile up Twin Run west of Goshen School, but because of the fault does not reappear immediately west of the Medina capping the ridge at this point. A quarter of a mile east of the school the steeply descending arch of White Medina is followed by the Clinton. In the syncline at this point both limbs are steep, so that the Clinton comes up again within half a mile toward the east. In the center of this syncline is a narrow anticline marked by the Keefer Sandstone. East

of a small arch of White Medina at Tea Knob, there is still another narrow area of Clinton.

Farther southwest the two areas of White Medina come together, and the Clinton occupies the area from Ruleman Mountain to Bobs Mountain and Simmons Mountain. East of these mountains is an area of Clinton half a mile wide parallel to the mountain. This brings the eastern margin of the Clinton to a point 0.4 mile west of Harper on East Dry Run. At this point the Keefer is a typical grayish sandstone, with rounded grains of silica near the bottom and the top, but finer in texture in the center. The dip is 34° southeast.

The Clinton lies northeast and east of Franklin, along a low Medina arch that rises above the drainage line north of Greenawalt School where the Clinton appears half a mile west of the road. As the Medina rises higher farther to the southwest the Clinton borders it with a width of one-fourth mile. In this region a marked difference in the Keefer is noted as compared with the Keefer seen west of South Branch River. On the east side of this Medina arch the Keefer is finer in texture, a portion containing small rounded pebbles but most of it finely siliceous, much like the Bloomsburg. On the western side of the Medina arch, the Keefer, which usually forms a conspicuous topographic feature, is concealed.

These two areas of Clinton continue southwest along the White Medina which, past Hardscrabble Church, forms the high arch of Long Ridge with its flanks bordered by Clinton. Then, as the Medina plunges southwest the Clinton next disappears concealed beneath the later rock.

Half a mile to the southeast of the White Medina at Kummel the Keefer of the southeast limb dips 73° southeast. Here the upper half of the Keefer is quartzose as in the western limb but the lower half is finely siliceous and grades down into the yellowish shaly Clinton below. In places there are thin streaks, local, that are strongly ferruginous, and in the road fragments of ore were seen and collected that had apparently come from farther along the hill to the north.

A little over a mile northeast of Sugar Grove the Keefer forms the axis of a syncline at a turn in the road. The base

is here of sandstone with rounded grains of quartz cemented with silica but in the upper half or more it is a light yellowish fine siliceous rock.

Along the whole area east of the regions above mentioned the Clinton does not rise again above the drainage line within the limits of the county, the surface of that area being occupied by later strata. There is, however, another narrow area in which the White Medina Sandstone flanked by Clinton sandstone does reach the surface. It is along a double fold the axis of which lies between Jack Mountain and South Branch.

The best location for outcrop of iron is at Iron Knob, near Dickinson Mountain School, where in an anticline the iron-bearing strata come to the surface in buff shale considerably below the Keefer, which is visible near the road. The shale is here thicker than along North Fork. The ore is centered in this general portion of the county. Farther to the northwest, to the southwest, and along River Ridge there is limestone that is not accompanied by ore. A calcareous phase of the Clinton is to be seen at Moyer Gap.

The Clinton sandstone, known as the Iron Sandstone, that is universally near the base of the Clinton in the central part of the county, is as ferruginous as it is along North Fork, but it does not contain iron enough to constitute an ore.

Such ore as is found is highly fossiliferous, consisting chiefly of Ostracoda (Bonnemaia). For analyses of the ore see chapter on iron under Economic Geology.

Paleontology.

The best index fossils of the Clinton of Pendleton County are three genera of ostracods: Bonnemaia, Mastigobolbina and Plethobolbina. Other fossils that are of special value are given in the following list:

Buthotrephis gracilis var. intermedia
Orbiculoidea clarki
Pholidops squamiformis
Rhipidomella hybrida
Stropheodonta corrugata var. pleuristriata (Index)
Camarotoechia neglecta

PLATE XXXII.—Keefer Sandstone, 0.3 mile south of Dickinson Mountain School. (Photo. by Paul H. Price).

Uncinulus stricklandi (Index)
Atrypa reticularis
Trematospira camura
Pterinea emacerata
Hormotoma
Bellerophon marylandicum
Calymene cresapensis.

Bonnemaia, as described by Ulrich and Bassler, is characterized by the presence of a thick U-shaped lobe. The posterior lobe may be divided in its upper half by a short sulcus and the anterior lobe crowned by a curved angular crest. One species only (Bonnemaia notha) is reported from the Middle Clinton, all others are reported from the lower and middle parts of the Upper Clinton[2].

Mastigobolbina, as described by the same authors, is characterized by a narrow posterior lobe, a large anterior lobe, and a median lobe that tapers downward, sometimes ending in a whip-lash-like extension. The various species are reported divided between the Lower, Middle, and Upper Clinton[2].

Plethobolbina, is not so well represented as the two genera just named. There is a single sulcus, median in position, extending obliquely backward[2]. In the lower portion of the Clinton the shaly buff limestone contains trilobites and ostracods among which Calymene cresapensis, Bollia, Bonnemaia, Lepterditia elongata var. willsensis, and Coelospira hemispherica, a Stropheodonta and Buthotrephis gracilis var. intermedia are recognized. In the central portion occur Pholidops squamiformis and Tentaculites minutus in abundance along with fragments of trilobites. In the upper portion were found crinoid stems, Pholidops squamiformis, and Tentaculites minutus. In the blue limestone are noted Atrypa reticularis, Uncinulus stricklandi, and Camarotoechia neglecta.

The most convenient Report bearing on the Paleontology of the Clinton of West Virginia is to be found in the volume on the Silurian published by the Maryland Geological Survey. In it may be found complete lists of fossils from the various parts of the Silurian of that State. A complete list of fossils

[2]Silurian, Maryland Geological Survey, pp. 576, 596, and 635.

may also be seen in the Report on Hampshire County of the West Virginia Geological Survey.

Locations.

In Moyer Gap, where the Clinton dips northwest and the strata occur in progressively higher beds toward the northwest, four collections were made. The first **(No. 30A)** is from the thin shaly grayish-brown sandstone that lies above and west of the White Medina. In this deposit are numerous Calymene cresapensis, Camarotoechia andrewsi, Stropheodonta corrugata var. pleuristriata, Plethobolbina, and Bonnemaia.

The second collection **(No. 31A)** is from near the middle of the Clinton in a dark buff shaly sandstone in which Orbiculoidea and Tentaculites minutus are very abundant and Calymene cresapensis, Stropheodonta corrugata var. pleuristriata, a form like a genal angle of a large trilobite, and algal impressions are present.

The third collection **(No. 31B)** is from the upper part of the shaly sandstone from which the second collection was taken. It contains essentially the same fossils. Tentaculites minutus is abundant. With these are Calymene cresapensis, Stropheodonta corrugata var. pleuristriata, rod-like impressions as of an alga, and part of the pleural area of a large trilobite. Indistinct impressions as of ostracods are present some of which seem to be of Plethobolbina.

The fourth collection **(No. 30B)** is from the west part of the gap, beneath the Keefer Sandstone, and in a dark-gray fossiliferous limestone. Here are found Rhipidomella hybrida in considerable numbers. With it are associated Pterinea emacerata (?), Camarotoechia neglecta, Pholidops squamiformis, Hormotoma sp., Bonnemaia, and Mastigobolbina. The position and the presence of Tentaculites minutus and of Calymene cresapensis link this limestone with the Clinton rather than with the Niagara. Orbiculoidea and Stropheodonta corrugata var. pleuristriata are reported both from the Clinton and from the Niagara.

One and a fourth miles in a straight line northwest from

Sugar Grove the question arose as to whether a certain bed of yellow sandy and somewhat micaceous shale was Clinton or Niagara. On the answer depended the decision as to whether a neighboring sandstone not fully exposed was Bloomsburg or Keefer. The presence **(No. 53)** of Mastigobolbina and of Stropheodonta corrugata var. pleuristriata determined the outcrop to be that of Clinton Shale. With these fossils were associated crinoid stems and fragments that appeared to be of Uncinulus. Therefore the shale is above the Keefer Sandstone and below the Bloomsburg.

At another point at this same locality a collection **(No. 49)** was made in the Clinton just below the Keefer Sandstone. The relation was evident from the presence of Uncinulus stricklandi, with which were associated crinoid stems, a pelecypod, a Bellerophon, and possibly Atrypa reticularis.

On the road northeast-southwest at a point half a mile northwest of Dahmer the question arose as to whether a certain sandstone close to the west side of the road was Keefer or Bloomsburg. In the collection **(No. 41)** made in black limestone fifteen feet below the bottom of this sandstone there is a great abundance of black ostracods: Mastigobolbina and Plethobolbina, both of which appear in the Upper Clinton. There are also a few fragments of brachiopods too imperfect for identification. Therefore the sandstone above is the Keefer Sandstone.

Two-tenths mile south of Dahmer and to the northwest of a fold of Medina the question arose as to whether a buff sandy shale might not be Niagara instead of Clinton. The shale **(No. 25)** contains Bonnemaia and Mastigobolbina, both of which are Clinton genera. With these are associated Buthotrephis gracilis var. intermedia, Pterinea elongata, and possibly Uncinulus. The shale is therefore Clinton.

A quarter of a mile west of Dahmer the occurrence of two beds of light-colored quartzose sandstone dipping southeast, neither well exposed, raised the question as to whether the southeast sandstone is Keefer or Bloomsburg. The collection **(No. 26)** made in the yellow shale between the two sandstones yielded Bonnemaia and Plethobolbina, which are index

fossils of the Clinton Shale, below the Keefer. Therefore the eastern of the two beds of sandstone is the Keefer. With the above-named fossils are also associated Stropheodonta corrugata var. pleuristriata, Trematospira camura, Pholidops squamiformis, Orbiculoidea clarki, and crinoid stems.

The Clinton-Niagara Contact.—The top of the Keefer Sandstone is taken as the boundary between the Clinton and the Niagara Series. While somewhat of conglomerate is noted in the Clinton the change on the whole is from a limestone or ferruginous shale to a conglomeratic sandstone, Keefer, marking strand conditions again. It is typically a grayish sandstone with rounded grains of silica near the bottom but finer in texture in the center. The pebbly (strand) conditions are more widely noticeable at the top than at the bottom of the succession of beds. Following the conglomeratic Keefer Sandstone there is a gradation again through shale to a limestone but with no variation in dip detected between the Niagara above and the Clinton below. If there were originally any difference in dip that difference has been obscured or obliterated in the folding that took place later. Therefore the contact at the overlap is considered a disconformity.

NIAGARA SERIES.

(Map Symbol, Sna).

The relation of strata in the Niagara Series is as follows:

	Feet.
Shale, yellowish, clayey	123
Shale, gray, and limestone interbedded	48
Limestone, dark	40
Total	211

At Seneca Rock, where the above measurements were made the entire thickness of the Niagara stood on edge so that it could be measured with tape line. Half a mile to the northeast the portion exposed was a shaly limestone, the entire thickness as determined by pacing being 250 feet. At the

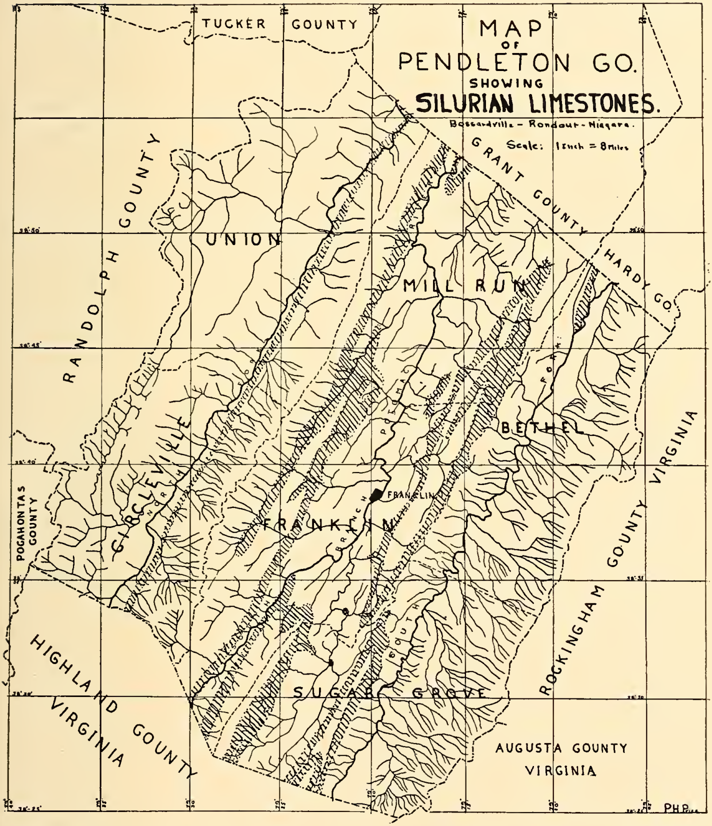

Figure 20.—Map of Pendleton County showing Silurian Limestones.

mouth of Shafter Run the Niagara Limestone and Shale are beneath the river bed, but farther on near the Hardy County line they are exposed and in the same vertical position. Southwest from Seneca Rock they are in an overhang. Just east of Circleville the overhang is such that the dip is 51° 20′ southeast. Here (in the true stratigraphic order) 80 feet of shale lie over 70 feet of limestone. At Dry Run 90 feet of gray shale referred to the Niagara are involved in the overturn, the dip being 51° southeast and the strike N. 17° E.

Figure 20, page 115, prepared by Paul H. Price, shows the Silurian Limestone (Bossardville, Rondout, and Niagara) areas of Pendleton County. These areas are shown in greater detail on Map II accompanying this Report in a separate Atlas.

West of North Fork the Niagara Series disappears beneath later strata and does not reappear in that direction within the limits of the county.

East of North Fork Mountain.—On the east slope of North Fork Mountain the Niagara outcrops along the mountainside for a vertical distance of 120 feet, which, with a dip southeast of 23° 20′ would require a thickness of 110 feet. It outcrops in a long band in the eastern slope of North Fork Mountain, on both sides of Long Ridge and of Dickinson Mountain and along South Fork Mountain. In the central part of the county it forms a part of lines of strata exposed by erosion of numerous short folds in that region. The shale is not resistant but the cherty limestone helps to form ridges.

Paleontology.

The forms that have been found of use from the Niagara of Pendleton County are the following:

Algae
Buthotrephis gracilis
Uncinulus obtusiplicatus
Camarotoechia andrewsi
Camarotoechia litchfieldensis
Leptaena rhomboidalis
Hormotoma marylandica
Leperditia elongata var. willsensis

Eukloedenella simplex
Kloedenella.

Of these forms Uncinulus obtusiplicatus, Camarotoechia andrewsi, Hormotoma marylandica, Eukloedenella simplex, and Kloedenella have been reported from the Niagara only. and are therefore to be considered index fossils. Of these the three ostracods are to be considered most valuable because generally best preserved. Buthotrephis gracilis is also reported from the Clinton, a form that is here of little value because of indistinctness. Leperditia elongata var. willsensis is also reported from the Bloomsburg, but the Bloomsburg is so very different from the Niagara Shale and Limestone that the character of the material combined with the presence of Leperditia elongata var. willsensis is the equivalent of an index fossil.

Locations.

No. 14.—One mile northwest of Ruddle, in limestone just to the east of an exposure of sandstone is a limestone the relation of which it is desired to ascertain. If the limestone is found to be Niagara the sandstone is Bloomsburg. If the limestone is Clinton then the sandstone is Keefer, a point of considerable importance in mapping, since the Keefer comes just below the Niagara and the Bloomsburg lies just above the Niagara. It also serves as a check in comparing the Keefer and Bloomsburg across the county to ascertain whether either or both change in character. The results are embodied in the descriptions of these two sandstones. On examination the limestone is found to contain numerous individuals of Kloedenella, many Eukloedenella, and a few large Leperditia elongata var. willsensis. The fragments of brachiopods correspond to Camarotoechia andrewsi, and a gastropod to Hormotoma marylandica. These all agree in proving that the limestone is Niagara; hence the sandstone to the east, the direction of the dip, is Bloomsburg.

No. 51.—Half a mile north of Goshen School. Here near the road there is White Medina on the mountain top above to

the east, a bluish limestone at the level of the road, and a sandstone on the opposite side of the valley west. As this bluish limestone by the road contains Eukloedenella, Kloedenella, Camarotoechia andrewsi, and Hormotoma it is an outcrop of the Hormotoma zone of the Niagara. **No. 50,** from a little above where No. 51 was taken, contains Kloedenella and Leperditia alta. Hence, in the talus between this limestone by the roadside and the Red and White Medina above in the mountain there is a fault, with downthrow on the west side. From the White Medina eastward the sequence in strata is regular, and from this Niagara outcrop westward the order is also regular. The sandstone on the opposite side of the valley is found to be Keefer, and the beds outcropping along the ravine westward are found to be Clinton. The fault is discussed in the chapter on cross-sections.

No. 11.—This collection was obtained in the bed of Twin Run about three-fourths mile northwest of Goshen School from a black limestone that contained small veins of calcite along some of which there was evidence of slipping. In this limestone were found Eukloedenella, Kloedenella, Hormotoma marylandica, Camarotoechia andrewsi, an internal cast of a valve like that of Pterinea flintstonensis, and fragments of Cuneamya ulrichi, and of Whitfieldella marylandica. The first three named make it evident that the outcrop is that of Niagara Limestone. With this conclusion the fragments of brachiopods and pelecypods agree. It is evident that Niagara Limestone (McKenzie) underlies the valley west of Castle Mountain.

No. 15.—This collection was obtained half a mile southwest of Goshen School, on the west flank of Castle Knob, from a dark shaly limestone containing veins of calcite. Here were found Camarotoechia andrewsi, Hormotoma marylandica, Eukloedenella, and Kloedenella, which determine the limestone to be that of the Hormotoma zone of the Niagara (McKenzie).

The collection and that numbered 11 also bear upon the location of the fault.

No. 10.—This collection was obtained 0.15 mile east from Friends Run School where there is a dark, dense, fossiliferous

limestone in thin layers. Of brachiopods there is an abundance of Camarotoechia andrewsi and Uncinulus obtusiplicatus. Of ostracods there are three distinct species, each of which is abundantly represented: Leperditia alta, Eukloedenella simplex, and a Kloedenella. All of these are Niagara forms.

No. 41.—This collection was obtained about half a mile northwest of Dahmer, from a black limestone that contained infiltrated calcite and bore slickensided surfaces, the top of the limestone being fifteen feet below the Bloomsburg Sandstone near by. The limestone consists of a mass of black ostracods in which forms of Eukloedenella are very abundant. These alone refer the limestone to the Niagara (McKenzie). With these are found many Kloedenella that are judged to be subovata, to which they correspond in relative dimensions and in position of sulci. With these are found the valve of a small pelecypod that is nearest like Modiolopsis, and a few fragments of brachiopods, the best of which in shape, size, and markings agree with Homeospira evax var. marylandica.

The Niagara-Salina Contact.—In the Niagara the local gradation is from limestone through shale to a sandstone that has no distinctive fauna. Thus, whether the break should be considered at the bottom of the Bloomsburg or farther up, as at the top, is not determined from data within this area. The Bloomsburg strata are on the whole more closely related to the shallow-water deposits found above and farther north than they are to the deeper-water deposits found farther down in the Niagara. To that extent the local conditions sustain the decision to place the dividing plane at the base of the Bloomsburg Sandstone. The relation is wholly that of a disconformity. Above this disconformity is a dark reddish-gray sandstone nine to fifteen feet thick west of North Fork Mountain, and a dark-gray fine-grained sandstone seventeen to thirty-two feet thick east of North Fork Mountain. The presence of Scolithus and Arthrophycus is also somewhat distinctive Beyond this the gradation upward is through a calcareous shale to a limestone.

SALINA SERIES.

The Salina Series includes three members:

	Feet.
Bossardville Limestone	266–481
Rondout Shale and Limestone	210–430
Bloomsburg Sandstone and Shale (at the base)	30

BLOOMSBURG.

(Mapped with Rondout.)

West of North Fork Mountain.—West of Seneca Rock the Bloomsburg Sandstone is a dark, reddish-gray sandstone 9 feet thick, standing on edge between the buff shale and dark limestone of the Niagara below and the dark Rondout Shale and Limestone above. This is somewhat less than found half a mile to the northeast where a thickness of 15 feet is found. Southwest from Seneca Rock the Bloomsburg is involved in the overturn. It is 15 feet thick in the Circleville Gap.

To the westward it disappears beneath the later strata and does not reappear within the area of the county.

East of North Fork Mountain.—East of North Fork Mountain the Bloomsburg is in general a fine-grained siliceous rock, partly reddish and partly of a dark-gray shade. In this it is in contrast with the Keefer, which contains beds of rounded quartz pebbles cemented by quartz, though in places a portion of these beds consists of a fine dark-gray siliceous rock.

1.9 miles northwest of Ruddle the Bloomsburg dips 65° northwest. Measured in a horizontal direction and then corrected for dip the record is as follows:

	Feet.
Sandstone, gray, dense, fine-grained	2.3
Sandstone, gray, dense, fine-grained	4.5
Shale, dark-gray	4.5
Sandstone, dark-gray, shaly	15.6
Total	26.9

2.8 miles a little north of west from Franklin the Bloomsburg appears along Friends Run. Here it is a gray non-cal-

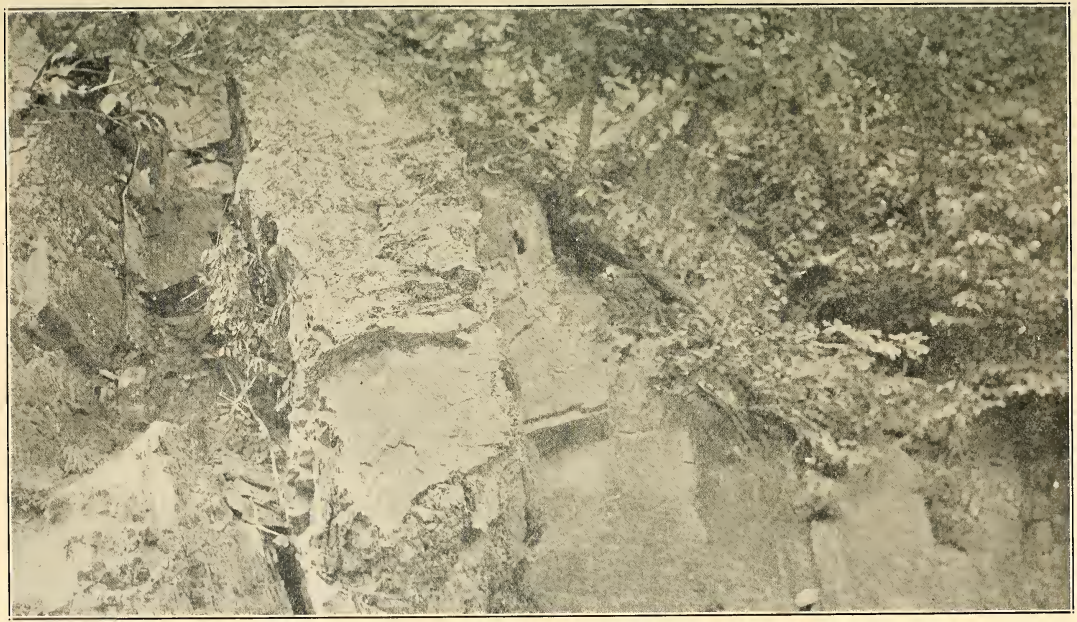

PLATE XXXIII.—Bloomsburg Sandstone, near fault-line in Smoke Hole. (Photo. by Paul H. Price).

PLATE XXXIV.—Bloomsburg Sandstone, 1 mile east of Kline Post-Office. (Photo. by Paul H. Price).

careous sandstone 17 feet thick, composed of thin layers up to one foot in thickness. Here it contains Scolithus and Arthrophycus.

East of High Rock School in the northern part of the county the sandstone is thin-bedded and reddish, dipping to the northeast. The measurement here gave a thickness of 32 feet. Two and a half miles southwest, at a point three-fourths mile west of Greenawalt School it consists of 30 feet of fine-grained siliceous rock, dense layers at bottom and top, with shaly layers in the center.

At New Erection School two and a half miles a little south of west from Fort Seybert the Bloomsburg is finely siliceous and slightly reddish. A mile and a half northeast of Sugar Grove the Bloomsburg dipping 57½° northwest is 31 feet across. This gives a thickness of 26 feet. It is here composed of yellowish siliceous layers up to five inches in thickness.

Paleontology.

But little evidence in the form of fossils can be obtained directly from the Bloomsburg itself. Direct evidence must be from the character and sequence of the different beds that compose it and the variations noted across the county, as given in the description of strata. There is, however, indirect evidence of positive value that is presented where such evidence is considered. This consists in recognizing that immediately below the Bloomsburg the strata and fossils present the characteristics of the Niagara, while immediately above the Bloomsburg the strata and fossils present the characteristics of the Rondout and Bossardville. The specimens collected contained an abundance of algal markings but no other fossils.

Locations.

No. 9.—Just west of Friends Run School lies an outcrop of seventeen feet of a gray and reddish sandstone in thin layers up to one foot in thickness, with the thin bands showing

lamination of uneven dark and light layers, and sandstone that in its character and relations is clearly Bloomsburg. The sandstone has an unusual amount of impressions of rounded and branching stems, some of them flattened. They can not be Arthrophycus because they are not "marked transversely by ridges as if articulated", neither do they bear a median depressed line. They are, however, marks as of algae, some parallel to the stratification, some at right angles to the stratification as if growing in the mud. On the surface of layers are rounded markings that appear like filled-in tubular places of algae or of worms (Scolithus). The side views indicate algae rather than worms.

RONDOUT.

(Map Symbol, Srd).

West of North Fork Mountain.—A dark shale standing on edge is partially exposed in the low ground west of Seneca Rock, but so concealed on the whole that its thickness can not be measured. In the ravine half a mile northeast of Mouth of Seneca 210 feet of Rondout appear as a calcareous shale between a distinct Bloomsburg below and a distinct Bossardville above. In other ravines it was not found well enough exposed for measurement. West of the valley of North Fork it is concealed by later formations and in that direction does not appear again within the county.

East of North Fork Mountain.—Along the east side of North Fork Mountain the Rondout is a dark siliceous limestone with many Ostracoda and some Camarotoechia, the formation lying in narrow bands along the flank of the mountain. At the quarries three-fourths mile west of Ruddle the Rondout is 430 feet thick. Three miles west of Franklin it outcrops along Friends Run.

It outcrops two miles east of Ruddle, and farther south near Harper School. It also appears half a mile west of Sugar Grove, near High Rock School, and near Greenawalt School. Near Fort Seybert it outcrops along several minor folds between South Fork Mountain and Deer Run, and, in

line with these toward the southwest, it outcrops west of Oak Flat.

Paleontology.

The forms that have been found of use from the Rondout of Pendleton County are the following:

Camarotoechia litchfieldensis
Spirifer vanuxemi
Leperditia alta
Leperditia elongata var. willsensis.

As all of these forms excepting Leperditia elongata var. willsensis have also been found in the Bossardville, they can not be considered index fossils of the Rondout. On the other hand, the presence of these and the absence of Rhynchospira globosa, Hindella congregata var. pusilla, Hindella congregata var. Rotundata, Leperditia mathewsi, and Leperditia scalaris var. praecedens, all common in the Bossardville, make a strong, almost perfect argument for the Rondout. This is rendered complete by the presence of the dark, often calcareous, shale (Rondout) beneath the thin-bedded black limestone (Bossardville).

Locations.

No. 4.—At a place 1.3 miles northeast of Upper Reeds Creek School, and 2.2 miles northeast of Ruddle, the dark thin-bedded limestone contains an abundance of large Leperditia elongata var. willsensis, the presence of which indicates Rondout strata. There are also two fragments that appear to be of Spirifer vanuxemi, and several imperfect sections of a flat-coiled gastropod. Here the Rondout appears for a few rods along the axis of a fold.

No. 50.—One-half mile north of Goshen School. The dark limestone dipping southeast near the roadside is of a character and in a position that corresponds to the Rondout. Furthermore, the presence of Kloedenia and Leperditia elongata var.

willsensis confirms that decision. There is, however, a crushed conical specimen 11 millimeters long and 2.5 wide as thus flattened out, that is like a Styliolina, a form reported in the Clinton but not yet reported in the Rondout.

No. 7.—East of Friends Run School 0.45 mile a dark shaly limestone appears on the west limb of a syncline. The limestone contains many shells of a minute Leperditia and of some that are larger that appear to be Leperditia elongata var. willsensis. It also contains portions of a gastropod that is like Hormotoma marylandica. While Hormotoma is more common below the Bloomsburg than above it, the presence of the Leperditia refers the strata to the Rondout. This is confirmed by the position of the Bloomsburg to the west, and of the Bossardville to the east and then farther on to the east, of the Oriskany, all dipping southeast.

BOSSARDVILLE.

(Map Symbol, Sbo).

West of North Fork Mountain.—The Bossardville Limestone is not visible west of Seneca Rock, where it evidently lies beneath the river and flood-plain, and stands on edge like the adjacent strata. It appears by the river at the mouth of a ravine half a mile north of Mouth of Seneca as a dark banded limestone, but is not fully exposed either here or generally along this part of the valley.

At the mouth of Circleville Gap it is partially concealed, but well enough exposed to determine 266 feet as its thickness from measurement of dip, strike, and outcrop. Here it appears both in the trench and in a cliff by the river as a dense bluish limestone with somewhat of shale included. In Mick Run 100 feet are exposed, and in Dry Run 45 feet.

Toward the northwest the Bossardville is one of the formations that disappears beneath later strata and in that direction does not reappear within the limits of the county.

East of North Fork Mountain.—The best exposure of Bossardville Limestone is at the D. R. Keplinger lime-kiln

about three-quarters of a mile west of Ruddle. Here there are four distinct subdivisions, which, however, may be combined into two main divisions in measuring. The dip is 33° southeast.

Keplinger Quarry.

	Feet.
Limestone, gray, thin-bedded Limestone, gray, crinoidal	318
Limestone, gray, shaly or banded Limestone, gray, thin-bedded	163
Total	481

The Bossardville with its thin banded appearance is a conspicuous feature in the central portion of the county. Between North Fork Mountain and South Branch River it is exposed along two synclines to a point west of Franklin, where the Bossardville in the eastern syncline is continued southwest to Hammer Run.

Two miles east of South Branch River lies another region in which the Bossardville is conspicuous southward to Moatstown. Still farther east it is frequently at the surface in the folds that extend near High Rock School, and from west of South Fork Mountain southwestward; also near New Erection School. It is exposed along the eastern flank of Stone Mountain, but it does not appear above the surface east of South Branch.

In its fractured beds and easily eroded shaly portions are numerous underground drainage channels, because of which various streams disappear in ordinary weather, only to reappear farther downstream where folding of the strata and erosion bring these strata to the surface again. A most noteworthy illustration is at Circleville, where at times of low water what there is left of the river disappears in a crevice located on the east side of the river just above the town. There are, however, other beds in which small streams disappear for a time.

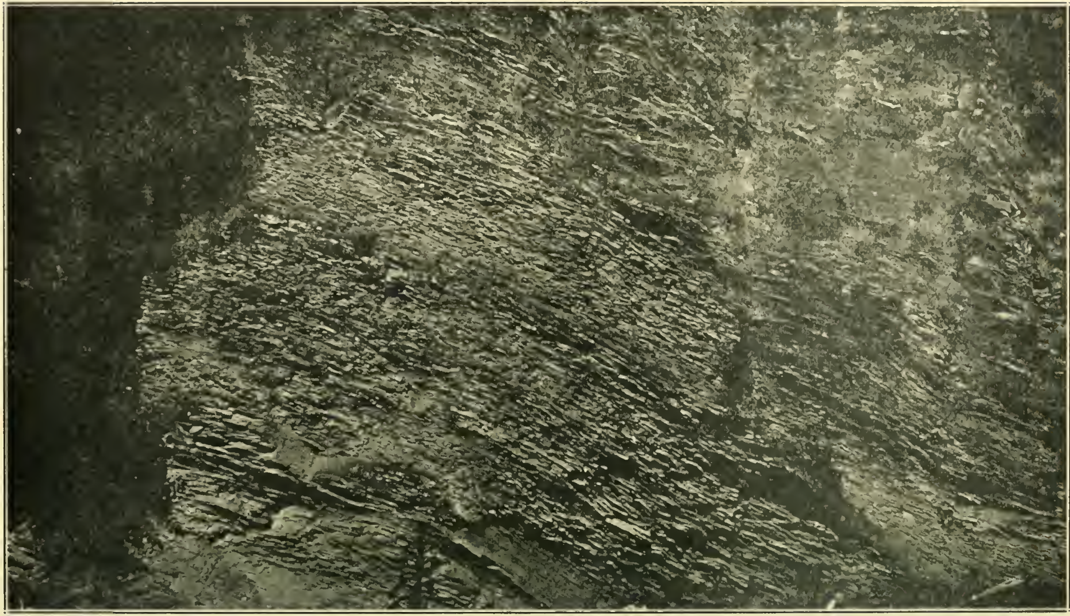

PLATE XXXV.—Camaratoechia andrewsi and Hindella congregata zone of Bossardville Limestone, 5 miles east of Friends Run School. (Photo. by Paul H. Price).

PLATE XXXVI.—Burning Lime from the Bossardville Limestone, along Hammer Run, 1 mile west of Ruddle. (Photo. by Paul H. Price).

Paleontology.

The forms that have been found of use from the Bossardville of Pendleton County are the following:

Aulopora tonolowayensis
Stromatopora constellata
Camarotoechia litchfieldensis
Spirifer vanuxemi
Rhynchospira globosa
Hindella (Greenfieldia) congregata var. pusilla
Hindella (Greenfieldia) congregata var. rotundata
Leperditia alta
Leperditia mathewsi
Leperditia scalaris var. praecedens.

Of these Aulopora tonolowayensis, Leperditia mathewsi, and Leperditia scalaris var. praecedens have been reported from the Bossardville only, and are therefore to be considered index fossils. Camarotoechia litchfieldensis, Spirifer vanuxemi, and Leperditia alta have also been reported from the Rondout, while Stromatopora constellata, Spirifer vanuxemi, and Rhynchospira globosa have also been reported from the Helderberg. These latter various forms are then to be considered only as marking the general horizon.

The Bossardville Limestone presents two marked variations between the lower part and the upper part of the beds. In the lower part Hindella (Greenfieldia) congregata lies in sheets, but associated with Camarotoechia litchfieldensis and Leperditia scalaris var. praecedens. In the middle portion Camarotoechia litchfieldensis is scattered through the various beds, and in one horizon is so abundant that it alone forms a zone at that level. With it are generally associated Rhynchospira globosa, Leperditia scalaris var. praecedens, and Buthotrephis. Some of the lower dark limestone is very fine-grained and without fossils, unless it be an occasional ostracod.

The upper part of the Bossardville is characterized by numerous beds of gray crinoidal limestone. With the crinoidal fragments are associated Lingula and Leptotrypa siluriens.

Locations.

No. 47.—0.85 mile up Hammer Run northwest from Ruddle there is a limestone quarry (D. R. Keplinger) in

Bossardville Limestone here dipping 33° southeast. West of the lime-kiln are the lowest beds of the Bossardville consisting here of a black limestone containing a great abundance of Hindella congregata, parts of a minute Hormotoma too imperfect for exact identification, and a few fragments of crinoid stems.

No. 46.—The specimens obtained near the kiln revealed three distinct fossil horizons in this lower portion of the upper half of the limestone. One layer contains an abundance of spindle-shaped branching forms each about 15 millimeters long and 2 thick. They are apparently algae of some kind, possibly Buthotrephis. Another layer contains imperfectly exposed smooth shells 8 millimeters in length and breadth, some a little narrower than long, some with faint lobe and sinus. These are considered Hindella congregata var. pusilla. In a third slab various sections of the same species are exposed among which are especially noted plates diverging from the umbo.

No. 48.—Farther up in the beds and farther east from the lime-kiln the limestone is of a lighter gray shale. Some parts are composed of masses of fragments of crinoid stems. One specimen encrusting the surface contained numerous minute round openings, about four to the millimeter. Of described forms it comes nearest to Leptotrypa. A fragment of a brachiopod corresponds to a portion of Rhynchospira globosa. A fragment of black limestone from this part of the quarry contains Leperditia mathewsi.

No. 20.—A mile in a straight line northeast of High Rock School, and close to the road, a collection was made in the dark-blue thin-bedded very fossiliferous limestone, here dipping 53° 30′ southeast. Here were found Hindella (Greenfieldia) congregata in special abundance, together with Camarotoechia litchfieldensis and Leperditia scalaris var. praecedens. Evidently this is the Hindella zone of the Bossardville.

Nos. 5 and 6.—On Friends Run ¾ mile nearly straight east from Friends Run School the Bossardville Limestone ap-

pears with varying dip. It is a dark-gray thin-bedded very fossiliferous limestone in which are found Aulopora tonolowayensis, Hindella (Greenfieldia) rotundata, Rhynchospira globosa (in large numbers), Camarotoechia litchfieldensis, and Leperditia scalaris var. praecedens. Close by is the Camarotoechia zone, in which there is a mass of Camarotoechia litchfieldensis, Rhynchospira globosa, and many Leperditia scalaris var. praecedens. Evidently these limestones are in the central portion of the Bossardville.

No. 16.—A quarter of a mile west of Oak Grove School there is an outcrop of dark-bluish limestone containing calcite crystals, the beds dipping 17° 30′ northwest. The samples collected are non-fossiliferous. However, a thin-bedded limestone above is a Camarotoechia zone, and in the hillside below there is a 4-inch stromatoporoid zone (Stromatopora constellata?) which is reported not only from the Keyser but also from the middle of the Bossardville, where it seems to be located in this instance. Both of these lines of evidence and the character of the limestone itself agree in placing the strata in the Bossardville.

The Salina-Helderberg Contact.—The change is from the dark crinoidal limestone of the uppermost Bossardville, through the dark shaly limestone of the lowermost beds of the Keyser, to the dark dense limestone above. The contact is distinctly that of a disconformity, marked by a faunal change from the fauna of the Bossardville to that of the Keyser.

THE DEVONIAN SYSTEM.

With the exception of the Becraft, which has not been recognized in West Virginia, all the members of the Devonian System are to be found at the surface in Pendleton County, where the strata of this system occupy a considerable area of the county, especially in the eastern and western portions. The subdivisions are listed as follows, oldest at the bottom:

Devonian System
  Upper Devonian
    Catskill Series
    Chemung Series
    Portage Series
    Genesee Series

  Middle Devonian
    Hamilton Series
    Marcellus Series
      Marcellus Shale member
      Selinsgrove Limestone member
      Selinsgrove Shale member

  Lower Devonian
    Oriskany Series
      Ridgeley Sandstone
      Shriver Chert
    Helderberg Series
      (Becraft Limestone absent)
      New Scotland Cherty Limestone
      Coeymans Limestone
      Keyser Limestone.

LOWER DEVONIAN.

Lower Devonian Section 1.5 miles west of Oak Flat.

The following section of the Lower Devonian (Helderberg and Oriskany) was obtained a mile and a half west of Oak Flat, where the subdivisions are well exposed:

	Feet.
Lower Devonian:	
Oriskany Series (574 feet).	
Ridgeley Sandstone, reddish-brown, coarse, calcareous in base	339
Shriver Chert, chert, dark, calcareous	235
Helderberg Series (398 feet).	
(Becraft Limestone absent).	
New Scotland (15 feet).	
Limestone, with white chert; fossiliferous; with stromatoporoid zone	15
Coeymans (70 feet).	
Limestone, dark, shaly, crinoidal, extending from lowest portion containing Gypidula coeymanensis up to limestone with white chert	70
Keyser (313 feet).	
Limestone, dark, dense, crystalline, crinoidal (the "crinoid layer")	4
Limestone, dark, shaly	48
Limestone, conglomerate; with dark chert	12
Limestone, dark, shaly in part	55
Limestone, dark, dense	12
Limestone, dark, shaly	182

HELDERBERG SERIES.

(Map Symbol, Dhl).

West of North Fork Mountain.—Near Mouth of Seneca only a portion of the uppermost member (New Scotland) is visible for a few feet on the west side of the river beneath the terrace, where it is in a nearly vertical position. The remaining members of the Helderberg (Keyser and Coeymans) are evidently beneath the flood-plain, where they lie most of the way along the valley of North Fork.

A mile and a half north of Seneca Rock the Helderberg appears along the run at an elevation of 175 feet above the level of the river. Two miles farther on, just west of the mouth of Sawmill Run it is a conspicuous member in the hillside. A mile farther northeast, southeast of Pleasant Valley Church, the New Scotland is conglomeratic, beneath a yellow shale; and nearer the river the Keyser member is at the edge of the river flat. It is in this region that the Helderberg is best exposed west of North Fork.

Figure 21, page 135, prepared by Paul H. Price, shows the areas of Pendleton County in which the Lower Devonian Rocks crop to the surface. On Map II, accompanying this Report in a separate Atlas, these outcrops will be found in greater detail.

Southwest of Seneca Rock it is not well exposed along the river valley. To the northwest the Helderberg dips beneath later strata and does not appear again within the limits of the county.

East of North Fork Mountain.—Between North Fork Mountain and South Fork River the Helderberg is exposed at numerous places near South Branch River. One of the best locations in which to obtain measurements is a mile and a half west of Oak Flat, where it is in contact with Oriskany Sandstone. This is the section already given. The dip is here 52° southeast. At this point fossils were collected especially from the Coeymans.

The Helderberg is closely connected with the Oriskany, which it immediately underlies. Often the Oriskany arch

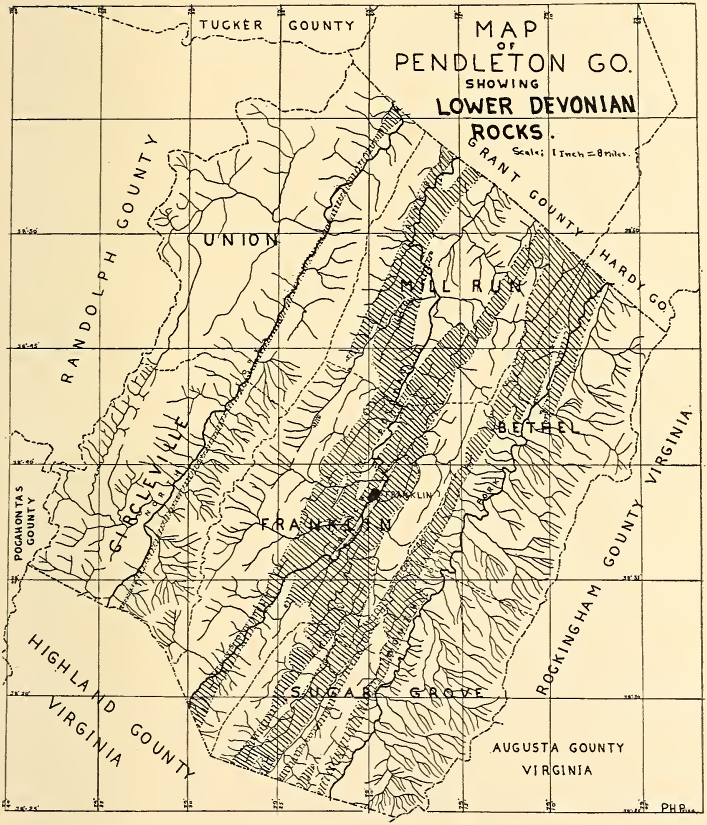

Figure 21.—Map of Pendleton County showing Lower Devonian Rocks.

rises sufficiently to reveal a considerable portion of the Helderberg beneath. Where the Oriskany has been removed and the Helderberg exposed to erosion the cherty character of both the New Scotland and the Keyser withstand erosion well, the chert being left as residual while the limestone dissolves out. Where fractured the limestone portion weathers out permitting underground drainage. It is in the lower portion of the New Scotland with its Spirifer macropleurus that the opening to the large cave in Cave Mountain lies, with entrance at 2500 feet above sea-level, 0.8 mile west of Kyle School, though passageways lead down to lower levels (Bossardville). Caves of smaller size are common in this limestone, some of which on high ground may prove to be large. In a similar horizon, with Spirifer macropleurus dotting the walls of the entrance, lies the entrance to Trout Cave at about 2150 feet above sea-level, 250 feet above the road at a point one and three-fourths miles southwest as measured along the highway from the bridge near the mouth of Smith Creek.

Paleontology.

The Helderberg Series presents three groups of fossils, two of which are widely distributed. The Keyser Member, the lowest in the Series, with its massive limestone enclosing dark chert, is marked by Spirifer modestus, a small, somewhat globular shell with large rounded beak. Fragments of crinoids are very conspicuous. The Keyser contains beds of Favosites pyriformis with Camarotoechia litchfieldensis and other forms near its base, and beds of Stromatopora constellata near its top, along with Favosites helderbergiae var. praecedens, Cyathophyllum, Schuchertella prolifica, and Tentaculites gyracanthus. The Coeymans Member, thinner bedded than that below and less cherty, is characterized by the presence of Gypidula coeymanensis, whose globose, somewhat trigonal form with large rounded beak overhanging the dorsal valve is of frequent occurrence. With this is also present Uncinulus nucleolatus. The New Scotland Member at the top, with its heavy beds of limestone including white chert, is characterized by beds of Spirifer macropleurus in the lime-

PLATE XXXVII.—An Oriskany-Helderberg arch cut through by Thorn Creek, 0.3 mile south of Franklin. In the left center the Oriskany can be seen almost vertical and near the center the New Scotland Chert and Coeymans Limestone are almost horizontal. A Marcellus valley in the foreground. (Photo. by Paul H. Price).

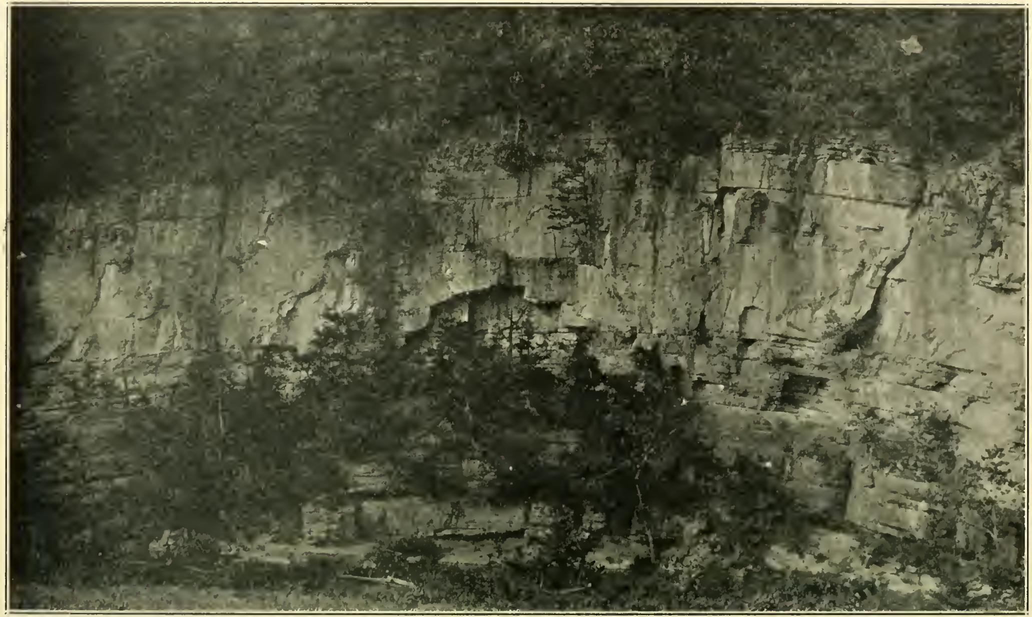

PLATE XXXVIII.—An excellent exposure of New Scotland Chert and Coeymans Limestone at "Bluehole" where the South Branch has cut through an arch of Oris kany and Helderberg. (Photo. by Paul H. Price).

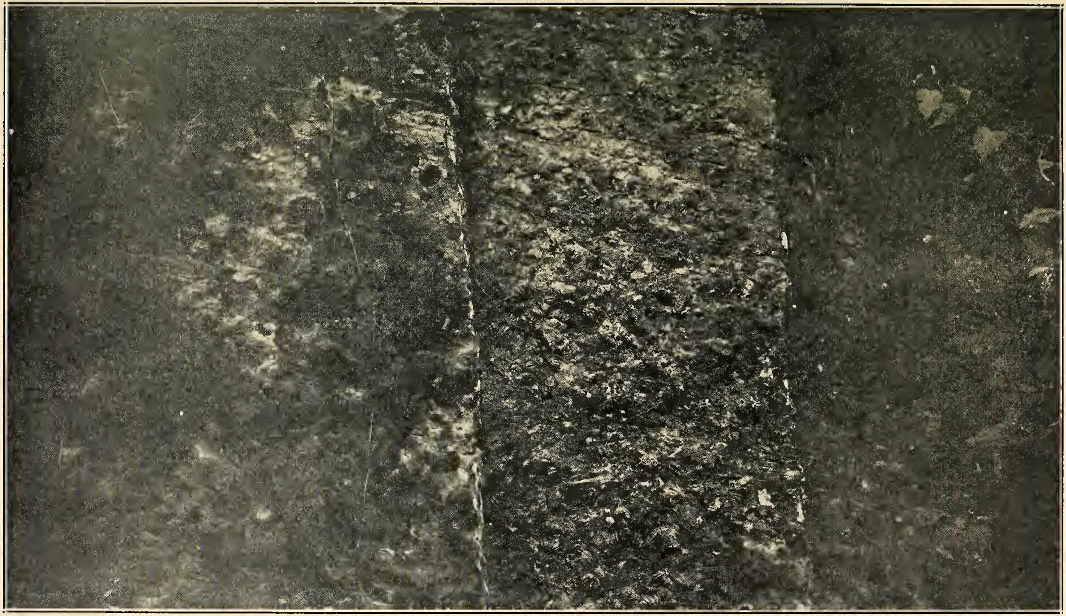

PLATE XXXIX.—New Scotland Chert, showing Spirifer macropleurus. East limb of Big Mountain entering Smoke Hole. (Photo. by Paul H. Price).

stone and Dalmanella planiconvexa in the shale, with which, in the limestone, are associated Spirifer perlamellosus, Schuchertella woolworthana, Dalmanella perelegans, and Meristella arcuata, among other forms.

Locations.

No special collection was made from the Keyser division of the Helderberg. The Keyser is a dark crinoidal limestone. Of the fossils that are found Fenestella cumberlandica, Cladopora, and Spirifer modestus serve as guide fossils. Tentaculites gyracanthus is characteristic of the upper portions of the Keyser and Stromatopora constellata sometimes occurs in abundance.

The place selected to represent the Coeymans is located one and a half miles a little north of west from Oak Flat, where the Coeymans is well exposed along with adjacent formations. Here from the lowest beds that contain Gypidula to the overlying beds with white chert (New Scotland) a thickness of 63 feet is exposed that is in thick beds near the base and in thin beds near the top. The limestone is crinoidal all the way and somewhat darker than the Coeymans farther north. In the heavy beds near the base are found **(No. 21)**: Ostracods sp.?, Actinopteria communis Hall, Stropheodonta arata Hall, Strophonella punctulifera Conrad, Gypidula coeymanensis S. and M., Spirifer cyclopterus Hall, Fenestella sp.?, and crinoid stems. In the dark crinoidal limestone near the center **(No. 23)** there is an abundance of Uncinulus nucleolatus. In the dark limestone near the top are the following **(No. 22**: Favosites helderbergiae, Rhipidomella oblata, Strophonella leavenworthana, Strophonella punctulifera, Gypidula coeymanensis, and Uncinulus nucleolatus.

Collection **No. 13** of fossils from the New Scotland was made three-fourths of a mile west of Upper Tract. Here the following fossils were found:

Streptelasma strictum
Stromatopora sp.
Orthostrophia strophomenoides
Dalmanella perelegans

Rhipidomella oblata
Spirifer macropleurus
Rhynchospira sp.
Trematospira equistriata
Platyceras reflexum.

Of these forms Spirifer macropleurus is the most important form because of its size, its distinct markings, and its occurrence in large numbers. Since it is confined to the New Scotland it makes an excellent index fossil. This large form commonly two inches across, each half marked by three to four coarse flutings or ribs, is not to be mistaken for any other form. As already stated this form is a conspicuous marker of the limestone at the entrance of the large cave in Cave Mountain and at the entrance of Trout Cave. It may also be seen in large numbers along the road to Smoke Hole. Three and a half miles southwest of Franklin, where the road turns sharply to the northwest and an arch of strata is crossed by both road and river, a stromatoporoid zone is noticeable in the New Scotland by the roadside.

The Helderberg-Oriskany Contact.—The change is that of a disconformity. A gradation occurs from the numerous limestone beds below with a very pronounced fauna (New Scotland), through a calcareous member that is getting more siliceous upward, into a distinct brownish sandstone (Oriskany), accompanied by a distinct change in fauna. The New Scotland is characterized by the presence of Spirifer macropleurus, and the Oriskany by the presence of Spirifer arenosus.

ORISKANY SERIES.

(Map Symbol, Do).

West of North Fork Mountain.—The Oriskany Sandstone appears beneath the terrace gravels at a point above midway in the portion of the terrace that is common to the south side of Seneca Creek and the west side of North Fork. It is the customary dense reddish-brown Ridgeley Sandstone, here standing on edge.

In the run half a mile northeast of Seneca Rock the Oriskany is exposed, where it appears to be 475 feet thick. A mile farther on the sandstone member (Ridgeley Sand-

stone) bounds the river valley on the east. From Evergreen Church on northeast to the county line Oriskany Sandstone lies in the hills that parallel the west margin of the valley of North Fork, producing resistant ledges that cause obstructions to road building and forming steep sides of gorges where the drainage lines cross the sandstone.

Southwest of Seneca Rock the Oriskany is at first in a bluff on the west side of the river, but farther southwest it is largely upon the east side of the river where it forms a steep hill bordering the river, as near Macksville. Still farther south it rises in the hills east of the river.

West of the North Fork it dips beneath later formations and does not appear again within the limits of the county.

East of North Fork Mountain.—East of North Fork Mountain the character of the Oriskany Sandstone is revealed along numerous mountains whose arched summits of brown resistant sandstone slope steeply to adjacent valleys, or stand in high ledges where streams have cut across the folds.

An excellent place to examine the Oriskany and measure it across the strike is found in the road and ravine a mile and a half west of Oak Flat. Here the dense resistant porous Ridgeley Sandstone is 130 feet thick, as determined by tape line. The lower dark limestone portion (Shriver Chert) is 312 feet thick, giving a total of 442 feet.

Often where the surface of this sandstone member is exposed may be seen cavities where large fossils have been dissolved out: Spirifer arenosus and Hipparionyx proximus, the planes of cavities marking the stratification. Often the fragments of sandstone litter the hillsides. Because of its resistant character the streams flow along more easily eroded neighboring shale, leaving the Oriskany to form the mountain-sides and rise in huge arches almost too numerous to mention. On the north and west of Upper Tract huge arches of Oriskany Sandstone determine the outline of Cave Mountain and Big Mountain. Farther south Franklin is situated on a low arch of Oriskany, to the west and southwest of which rise Entry Mountain, Lankey Mountain, Bible Knob, Moser Knob, Wilfong and Brushy Knobs, and Pickle Mountain. In the northern

part of the county the resistant Oriskany Sandstone rises in a band of arches en echelon southwest to Simmons and Jack Mountains. Farther east on the east side of the Medina arches a series of Oriskany arches extends from Borror School on the west to Jack Mountain; and, from the area east of High Rock School to Sweedlin Hill, another band of Oriskany arches extends southwest through Thorn Mountain and east of Stone Mountain, thence southwest across the county. With the exception of Sweedlin Hill, Oriskany arches are not to be found east of South Fork River.

Beneath the Oriskany arches and forming a conspicuous portion of these great masses wherever streams have cut across them are the subdivisions of the Helderberg Limestone, conspicuous wherever the arches rise high enough for erosion to bring to light the great masses of limestone beneath. The grandest of all these arches is exposed in the Smoke Hole area. Farther south along the same river (South Branch) arches are seen at Ruddle, where the Helderberg Limestone appears in the central part of the arch. Other arches cut through are visible on both sides of the river, one at two miles and another at one mile north of Franklin. South from Franklin the river follows the side of an arch which is cut through by Smith Creek, exposing an arch of Helderberg beneath the Oriskany, rising perhaps 75 to 80 feet above the road. Another arch is cut diagonally a mile farther south at the mouth of Dry Run on the east side of the river.

Along the South Fork and its tributaries an Oriskany arch is crossed near the Hardy County line, and by Kane Creek at South Fork Mountain. At Fort Seybert the river flows along the side of an Oriskany arch, while east of Wagner Knob, a mile west of Oak Flat and west of Sugar Grove, erosion brings to light Helderberg and Oriskany dipping steeply to the southeast. From the southern boundary of this county to Sweedlin Hill, South Fork River flows east of Oriskany ridges and folds.

Paleontology.

In the Oriskany Series Spirifer arenosus is the guide fossil

PLATE XL.—Oriskany Sandstone, slightly overturned, west limb of Cave Mountain entering Smoke Hole. (Photo. by Paul H. Price).

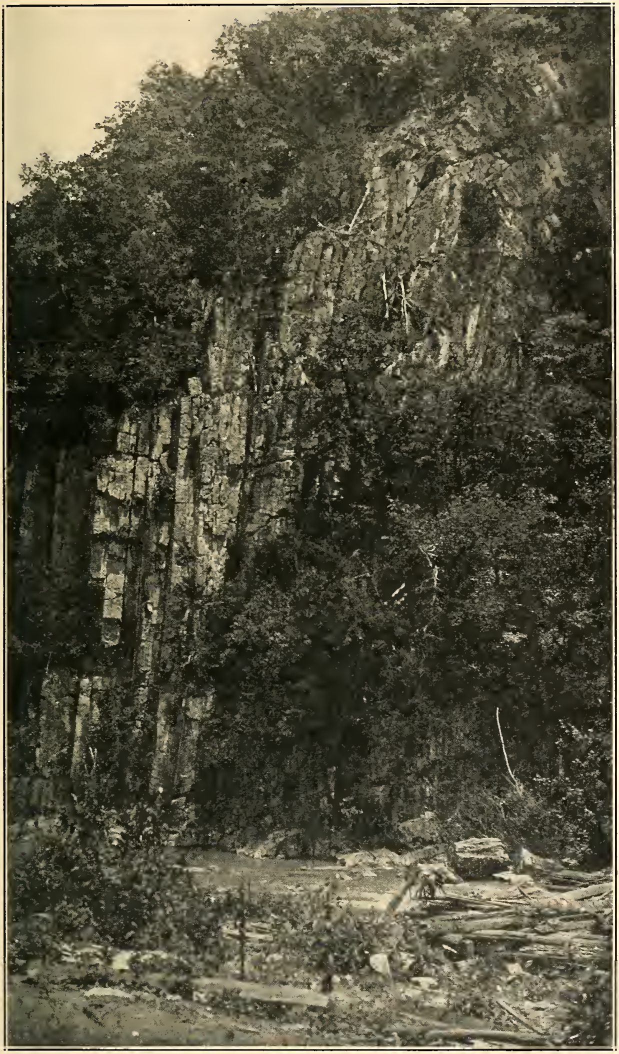

PLATE XLI.—Oriskany Sandstone, Smoke Hole Settlement. (Photo. by Paul H. Price).

and a form that is of frequent occurrence. This large, somewhat trigonal shell possesses coarse rounded corrugations even in the area of the faint lobe and sinus. Where a cast of the interior is exposed a prominent extension reaches beneath the beak of the shell. Hipparionyx proximus is also a guide fossil that, though common in places, is not so abundantly represented as Spirifer arenosus. The marks of the muscle attachment within the shell that so closely resembled the footprint of a colt suggested the name, this being a conspicuous feature. With these are associated several other brachiopods.

The evidence of the sandstone member of the Oriskany (Ridgeley Sandstone) is so conspicuous that the bed is not easily overlooked, and the presence of it is so common along the folds where it reaches the surface, already described, that but a few of the many outcrops will be mentioned.

Locations.

About a mile west of where the road north from Franklin crosses Friends Run the Oriskany is very fossiliferous **(No. 52)**. Here are imprints of Spirifer arenosus Conrad and Hipparionyx proximus Vanuxem, the sandstone appearing gashed where the numerous shells have been dissolved out. In the eastern part of this arch the Shriver Chert Member grades upward into the sandstone (Ridgeley). Another similar locality is a mile and a half west of Oak Flat **(No. 44)**. Here also the sandstone preserves numerous imprints of these shells, the shells themselves having been eroded away.

The Oriskany-Marcellus Contact.—The top of the Oriskany does not in all places contain iron ore. Where it does it indicates a place of concentration of iron in contrast with deposition of iron-stained sand. Each of these conditions indicates a time and place of erosion near at hand and a place of deposition along the shore.

One and a tenth miles west of Oak Flat a contact is nicely exposed between the Oriskany below and the basal shale of the Selinsgrove above. The Oriskany here dips 3° 50′ northeast. The top of the Oriskany is somewhat uneven. Between the Oriskany and the basal shale of the Selinsgrove above

there is a thin band of decomposed Oriskany, gray, with brownish inclusions, and some of the gray hard, not thoroughly decomposed. Two feet above the Oriskany the shale dips 1° 30′ northeast, a difference that is not more than can be accounted for by unevenness in the shale. The relation is that of an evident disconformity.

The dark Selinsgrove Shale above the contact is in marked contrast with the coarse brownish sandstone below the contact, and the faunal change is also very pronounced. Instead of the Spirifer arenosus fauna of the coarse sandstone there appears Anoplotheca acutiplicata and its attendant forms (See collection No. 38). The contrast is not due entirely to local change of environment ("facies"), for on reappearance of calcareous deposition the forms of the calcareous basal beds of the Oriskany do not reappear. (See collection No. 37A).

MIDDLE DEVONIAN.

The two series in the Middle Devonian may be described as follows:

Middle Devonian Section.

	Feet.	
Middle Devonian:		
Hamilton Series (566 feet).		
Shale, dark, fissile, non-calcareous, with two classes of concretions, one clayey and non-fossiliferous, the other calcareous and fossiliferous. As a whole it is not very fossiliferous. It is most fossiliferous in the southeastern part of the county and in the calcareous concretions of the north central part of the county..		566
Marcellus Series (447 feet).		
Shale, dark, fissile, somewhat concretionary but far less so than in counties farther north. The shale is divided into two portions by a bed of limestone (Selinsgrove) located about 100 feet from the base. The lower shale is called the Onondaga or Selinsgrove Shale, with fauna Onondaga-like, and like that of the Selinsgrove Limestone. The upper shale is essentially non-fossiliferous.		
Marcellus Shale member....................	332	
Selinsgrove Limestone member..............	15	
Selinsgrove Shale member..................	100..	447

The following figure, prepared by Paul H. Price, shows the areas of outcrop of the Middle Devonian Rocks in Pendleton County. Map II, accompanying this Report in a separate Atlas, shows these same areas in much greater detail:

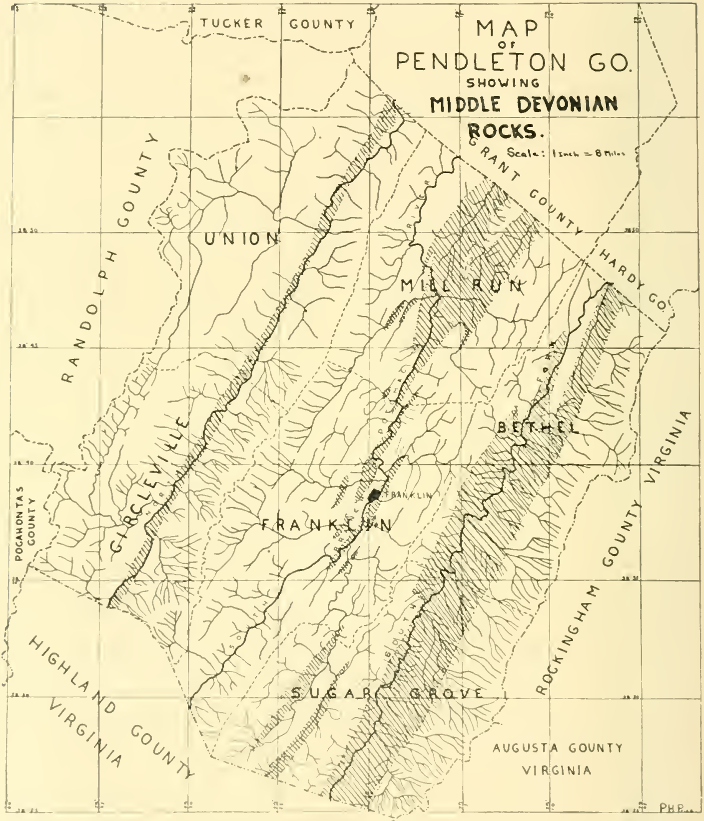

Figure 22—Map of Pendleton County showing Middle Devonian Rocks.

MARCELLUS SERIES.

(Map Symbol, Dm).

West of North Fork Mountain.—The Marcellus Shale lies beneath the terrace at Mouth of Seneca. Though greatly contorted it has the usual dark concretionary character. No limestone was found in it in this part of the county. As the contact with the Hamilton on the west can not be detected the thickness can not here be determined. The Marcellus, Hamilton, Genesee, Portage, and Chemung are here mashed, distorted, and compressed into half a mile. As a weak member the Marcellus has yielded to the great lateral pressure to which it has been subjected, and, as a member easily eroded, it lies beneath low ground along the river, and appears banked along the hillsides of the much more resistant Oriskany Sandstone. This member, as well as the Hamilton, Genesee, and Portage, dips west beneath the later formations west of the river valley and does not appear again within the limits of the county.

East of North Fork Mountain.—As west of North Fork Mountain so, too, east of North Fork Mountain the thick Marcellus Shale is an important valley maker, along with adjacent shale (Hamilton and Genesee). This is not so marked between North Fork Mountain and South Branch River, for west of South Branch River the folding of the strata is such as to make narrow valleys as erosion proceeds. At the entrance to the Smoke Hole region about a mile and a half above Upper Tract it may be seen as a remnant tucked in between two folds of Oriskany Sandstone. West of Timber Ridge Reeds Creek flows along a valley eroded into it. 0.6 mile west of Ruddle Brady Gap Run and Buffalo Run flowing from opposite directions unite with Hammer Run, the combined waters of which then flow southeast through an Oriskany-Helderberg gap north of Sand Mountain. Nearer Franklin the valleys in Marcellus to the west are wider, and the river itself, along which patches of Marcellus may be seen a mile south of Ruddle, and from one and a half to two and a half miles north of Franklin, here flows over from an eastern fold, along which

Marcellus Shale is repeatedly seen from a mile to three miles farther up the river. In the region west and southwest of Franklin that portion of the shale that corresponds to the Selinsgrove is not calcareous. It abounds in trilobites. Farther north near Upper Tract the river lies for four miles in a wide valley of Marcellus Shale. Indeed, this broad stretch of beautiful farm land owes its condition primarily to the erosion of shale, covered later by terrace deposits. A mile and a half north of Upper Tract this shale valley, not here occupied by the river, extends northeastward toward Petersburg. Between this valley along which the road from Franklin to Petersburg lies and the shale valley east of Sweedlin Hill the Marcellus is compressed into folds, of which there is a considerable area from Borror School southwest past Mount Horeb Church to Schmucker School.

A few rods south of Mount Horeb Church the Selinsgrove is well exposed, but contains only a few gastropods and faint indications of a few brachiopods. The section is as follows:

Section at Mount Horeb Church.

	Inches.
Shale, dark, dense, calcareous	21
Shale, dark, dense, calcareous, but not quite so resistant to weathering as the stratum above	17
Shale, dark, dense, calcareous, as resistant to weathering as the top stratum; gastropods	23
Shale, dark, calcareous, fissile	25
Shale, dark, calcareous, fissile, but more resistant to weathering than the stratum above	32
Shale, dark and fissile	32
Total	12½ feet

The strata here are badly disturbed; the dip is 31° 15′ northwest.

Sweedlin Hill is largely in Marcellus Shale. Just east and south of Pleasant Grove Church the Selinsgrove is exposed, and the Marcellus is evident along the east side of the road as far south as New Bethel Church.

The entire course of South Fork within the county lies along a valley eroded in Marcellus Shale and the accompanying Hamilton Shale, the Marcellus lying against the

ridges of Oriskany Sandstone on the west and extending between the folds. Half a mile north of Brandywine is a locality where the Selinsgrove is very calcareous. Here it consists of three beds of black limestone with shale between toward the west (basal portion), with more shale and thin limestone farther east, the whole covering an area 187 feet wide dipping 23° 15′ southeast, thus indicating a thickness of 74 feet. There is shale both to the east and to the west of this Selinsgrove Limestone.

Half a mile south of Sugar Grove there is upon the east side of the river the most remarkable bed of Selinsgrove Limestone within the county. It consists of fifteen feet of very fossiliferous crinoidal limestone, conglomeratic at base and near top, above 25 feet of shale (exposed). On the west side of the hill these beds dip 30° 50′ southeast, but on the east side of the hill they dip steeply beneath Stony Run, the top of the limestone appearing conglomeratic. West of the hill Oriskany Sandstone dips down beneath the river. East of the hill the Genesee is near at hand, with other strata in order toward the east. The Selinsgrove is here a purer limestone than elsewhere in the county, a distinction that seems due to original conditions of deposition.

Paleontology.

The part of the Marcellus Series that is especially fossiliferous is the Selinsgrove Limestone and the shale immediately beneath it. These beds are marked by the presence of Anoplotheca acutiplicata. (See collections Nos. 37 and 38). The black carbonaceous Marcellus Shale is essentially non-fossiliferous, though Liorhynchus limitare and Liorhynchus mysia are reported as occasionally found.

Locations.

At the mouth of Stony Run, half a mile southwest of Sugar Grove, a mass of limestone appears on the east side of the river. On the west side of the river, here 175 feet wide, occurs Oriskany Sandstone dipping 40° southeast to beneath

the river. Above this sandstone 25 feet of shale appears, also dipping southeast, and above this 15 feet of dark crinoidal limestone, dipping 26° southeast. A little farther east the dip changes to 15° 15′ northwest, then changes back again to a steep dip southeast. 965 feet farther east is the Genesee Shale with its Styliolina fissurella traceable for 650 feet to the Hamilton Shale, beyond which farther east are the light-colored Portage Shales.

The presence of Selinsgrove Shale near the river precludes the possibility of a slight normal fault, and the presence of Genesee, Hamilton, and Portage to the east without a repetition of Oriskany Sandstone precludes the possibility of an overthrust. In position the limestone thus corresponds to the Selinsgrove Limestone, which here in a slight reversal of dip is so located that it is protected from stream erosion. In character the limestone is very peculiar and unlike any limestone that had been seen.

No. 37A.—The dense basal beds of limestone conglomerate are full of fragments of crinoid stems, Fenestella, and a dark indistinct branching bryozoan that suggests Nemataxis fibrosum. There is also a coral that suggests Favosites, but the specimens are so completely changed to calcite that neither pores nor tabulae are distinct. Forms of brachiopods are distorted and incomplete. Such as appear correspond to Anoplotheca acutiplicata, Schuchertella variabilis, and Ambocoelia umbonata.

No. 37B.—In the middle beds of the limestone the dark branching bryozoans are even more abundant than in the basal layers. Here also are found fragments as of Fenestella, Schuchertella variabilis, Rhipidomella vanuxemi, Chonetes rugosus, and Bellerophon, in addition to Anoplotheca acutiplicata.

No. 37C.—The topmost portions include crinoidal and bryozoan remains with a few Atrypa-like weathered forms and a portion of a coarse ribbed shell that suggests Grammysia.

No. 38.—This collection was obtained from the shale that lies at a lower level than the limestone and appears near the road in the same locality where collections Nos. 37A, 37B, and

37C were obtained, at the mouth of Stony Run. Here in the dark limonite-stained shale were found:

Fragments of Crinoid stems
Pholidops hamiltoniae
Chonetes mucronatus
Chonetes rugosus
Ambocoelia umbonata
Anoplotheca acutiplicata
Loxonema hamiltoniae
Orthoceras.

Collections **Nos. 39 and 40** were obtained from outcrops on the east side of the hill at the above-named location. These are reported upon under the Genesee and Hamilton, respectively.

No. 43.—This collection was obtained on the west side of South Fork 1.2 miles due north of the mouth of Brushy Fork, one mile straight north of Wilfong School. The strata here are dense, black, carbonaceous shale impregnated with iron pyrites. Slickensides are common. Of fossils but two kinds were found. Several specimens of Ambocoelia umbonata were recognized and a single specimen of a minute Tentaculites. It is judged that this limestone is a portion of the Selinsgrove Limestone.

No. 12.—This collection was obtained three and a half miles southwest of Franklin on the north side of the road just before it turns west to pass through the gap at the north end of Sandy Ridge. Here, a few rods east of the Oriskany Sandstone, the dark shale is remarkably rich in fragments of trilobites that are found to be Phacops cristata var. pipa. A few corals were found that at the base revealed primary septae bent together as in both Stereolasma and Zaphrentis. Here also are found Ambocoelia umbonata, Orbiculoidea lodiensis var. media, Schuchertella variabilis, Lingula nuda, and casts as of stems of algae.

No. 8.—This collection was obtained on Friends Run a mile northwest of Franklin, a mile and a quarter west of the mouth of the run. The shale here is a dark calcareous shale containing an abundance of Ambocoelia umbonata. Next in abundance was Schuchertella variabilis. Here were also found

crinoid stems, a pygidium of Phacops cristata var. pipa, and Bollia ungula.

The Marcellus-Hamilton Contact.—In deposition there is a change from a black carbonaceous fissile shale to a brownish shale, a change entirely consistent with continuous deposition locally. In fossils the change is from a shale that is essentially non-fossiliferous to one containing Tropidoleptus carinatus and its associated forms. (See collections Nos. 19, 36, and 60). Even in the Hamilton the fauna is often very meager, though in places the forms are abundant.

HAMILTON SERIES.

(Map Symbol, Dhm).

West of North Fork Mountain.—At Mouth of Seneca the Hamilton, like the Marcellus, is compressed until its strata stand on edge, dipping sometimes southeast and sometimes northwest. No fossil horizons are detected and no opportunity exists to ascertain the thickness in this region. It seems impossible to detect the contacts of the Hamilton west of North Fork. All that is said with reference to the Marcellus west of the river is equally true of the Hamilton. It finally dips northwestward beneath the later strata.

East of North Fork Mountain.—East of North Fork Mountain the Hamilton is first encountered where the road from Franklin to Petersburg, having left South Branch River a mile north of Upper Tract, turns east across the area of shale which it follows all the way to Petersburg. Within a mile from the bridge over South Branch it enters an area of Hamilton Shale and continues in it to just north of Alt School, a distance of two and a half miles. The dark shale weathers into thin layers (is fissile) and contains numerous concretions that are of two types, one a clay-iron concretion, the other a dark-blue calcareous concretion. These latter calcareous concretions contain numerous fossils. The clay-iron concretions and the fissile shale have not been found fossiliferous in this region.

Along South Fork and Sweedlin Valley there are not

many points where the Hamilton can be recognized, since it lies under the river gravels most of the way. One of the locations where it is seen is in the road cutting south of Sweedlin Valley School. Another is in a flat a mile north of Oak Flat, where the folds of Oriskany throw the Hamilton to the east of Oak Flat. At Lone Poplar School it is evidently in the flat just east of the school, for a definite Genesee is found immediately to the east. At Sugar Grove it is covered by the river gravels, for Genesee strata lie to the east and Marcellus strata to the west. East of Crummet Church the Hamilton Shale begins and lies at the surface for 1315 feet, which, with a dip of 25° 30′ southeast, gives a thickness of 566 feet. At the county line it occupies a narrow belt 0.3 mile west of Palo Alto.

Paleontology.

The fauna of the Hamilton is often called the Tropidoleptus carinatus fauna because this form is generally present in Hamilton Shales. This brachiopod is commonly about three-quarters of an inch along the hinge-line and about four-fifths of that from the beak to the opposite margin (length). The form is somewhat rectangular, the ends of the hinge-line (cardinal extremities) being somewhat acute, but the other corners considerably rounded. One valve (dorsal) is nearly flat with a slight depression lengthwise through the middle. The other valve (ventral) is somewhat convex and has a slight keel extending parallel to the depression in the other valve. The plications of the shell are rounded and simple, about eighteen in number. Along with this shell are various other forms, one of which, Ambocoelia virginiana, is common. This shell is a small form about a tenth of an inch long, smooth, one valve plane, the other convex, with groove (sulcus), and with beak curved over the hinge-line.

Locations.

No. 19.—The location selected for a special collection of fossils from the Hamilton lies by the west side of the road 0.85

PLATE XLII.—Hamilton Shales. Fossil collection here. 0.3 mile south of Brushy Run Post-Office. (Photo. by Paul H. Price).

mile nearly east from Kyle School and 1.5 miles northeast of Upper Tract. Here the Hamilton consisted largely of a fine-grained silt abundantly stained with limonite. It had evidently been originally a calcareous shale, though at the present time all traces of limestone had been dissolved out, leaving a soft porous matrix permeated with openings yielding moulds and casts of numerous crinoid stems, tentaculites, orthoceratites, brachiopods, and pelecypods. None of these forms are perfect, so that identification has to rest upon the recognition of fragments. In the general mass there is a layer of a bluish color that is calcareous, containing an abundance of Ambocoelia virginiana.

The forms recognized from the fragments are as follows:

Stereolosma rectum (one specimen)
Crinoid stems (in abundance)
Lingula sp.
Stropheodonta perplana (a few fragments)
Stropheodonta inaequistriata (one specimen)
Chonetes coronatus (several)
Tropidoleptus carinatus (one)
Spirifer consobrinus (one specimen)
Ambocoelia virginiana (a large number)
Nucula varicosa (a few definite; many fragments)
Palaeoneilo marylandica (several)
Modiella pygmaea (one)
Aviculopecten sp. (one)
Cyclonema hamiltoniae (several)
Macrochilus hamiltoniae (several)
Diaphorostoma lineatum (?) (several)
Conularia undulata (four)
Orthoceras subulatum (many fragments)
Orthoceras cf. exile (several)
Spyroceras nuntium (several).

No. 60.—Six-tenths mile northeast of the bridge over South Branch on the road from Upper Tract to Petersburg the dark shale on the south side of the road contained Lingula sp., Chonetes coronatus, and Ambocoelia virginiana. An imprint of the latter measured 8 mm. from beak to opposite margin. The sulcus is well defined, muscle impressions are large, marks of diverging septa beneath the umbo pronounced, and concentric lines evident at the front. Other features are absent. In another specimen the beak is present, and a dorsal shell with inside view. These portions retain the line of the original

shell, a characteristic more noticeable in the Hamilton of this area than elsewhere in the county.

Close to the shale above mentioned is a fine-grained shale also stained with limonite that contains a large number of Styliolina fissurella Hall. Fragments that appeared to be of Stropheodonta perplana Conrad together with crinoid stems, were found close to the Styliolina fissurella. Apparently this latter collection is in part from the Hamilton and in part from the Genesee, for nowhere else was Styliolina fissurella found in the Hamilton, while it was abundant in the Genesee.

A collection (**No. 36**) was made from the Hamilton by the roadside a quarter of a mile southeast of Crummet Church (McDowell Quadrangle). The material is a dark clayey shale stained somewhat by limonite. The fossils that the shale contained are imperfect and crushed. Among the fragments the following were recognized:

Lingula sp.
Ambocoelia virginiana (in abundance)
Tropidoleptus carinatus (many fragments)
Nucula lirata (?)
Buchiola halli
Diaphrostoma (?) (crushed).

These are sufficient to indicate that the horizon is that of the Hamilton Shale. There are other fragments and impressions of pelecypods too imperfect to be identified.

No. 34.—Along the road two-tenths mile west of Palo Alto the black shale collected contains several Ambocoelia virginiana and an impression as of a small Nucula bellistriata. There are also two fragments of shells like Pterinea and two fragments of Orthoceras.

No. 40.—On the east side of the hill at the mouth of Stony Run, 0.6 mile south of Sugar Grove shale outcrops close to Stony Run. In the collection made where the stream first strikes against the east side of this hill were found the following forms:

A few crinoid stems
Lingula
Tropidoleptus carinatus
Ambocoelia virginiana (flattened until nearly disc-like)

Pterinea
Diaphorostoma lineatum
Platyostoma
Styliolina fissurella
Conularia undulata
Coleolus tenuicinctus.

No. 45.—This collection was obtained in a hill of Hamilton Shale nine-tenths mile due north from Oak Flat. Here the following were collected:

Amplexus hamiltoniae. (These are badly weathered, and contain markings that are apparently those of a sponge)
Lingula sp.
Chonetes coronatus
Ambocoelia virginiana
Stropheodonta perplana
Nucula sp.
Bellerophon leda
Loxonema hamiltoniae
Diaphorostoma lineatum
Phacops rana (pygidium and thorax).

UPPER DEVONIAN.

Upper Devonian Section.

These four series may be described in general as follows:

	Feet.
Catskill Series	
Reddish shales and sandstones, the heavy sandstone beds numbering eight. The only fossil horizon noted is about 100 feet below the top of the formation, where there are stems and indistinct twigs. The base is at the top of the Hendricks Conglomerate, and the top is at the base of a gray shale and sandstone full of strap-shaped leaf impressions....	2800
Chemung Series	
Thick beds of reddish-gray sandstone and shales, which in the compressed area west of River Ridge have a total thickness of but 674 feet, bu tin the broad synclinal area along the Shenandoah Mountain have a total thickness of but 674 feet, but in the plane selected is at the bottom of the thick beds of sandstone. The dividing plane at the top is the topmost bed of the Hendricks Conglomerate. Between the two but one definite conglomerate was noted and but one definite fossil horizon. 674 to 4865 feet..	4000 ?

	Feet.
Portage Series A gray shale with many thin beds of gray sandstone which in general are not over two feet thick except in the southern half of the area east of South Fork River, in which area there are a few thicker beds which it is necessary to include in the Portage. The beds are rarely fossiliferous, but occasionally traces of small pelecypods and brachiopods are found....	2674
Genesee Series A dark fissile shale with a few thin beds of dark-gray sandstone. These shales, so like Hamilton and Marcellus, are recognized by the characteristic fossils: Buchiola retrostriata and Styliolina fissurella..	196

Figure 23, page 161, prepared by Paul H. Price, shows the outcrops of the Upper Devonian Rocks in Pendleton County. These areas will be found in much greater detail on Map II accompanying this Report in a separate Atlas.

GENESEE SERIES.

(Map Symbol, Dg).

The Hamilton-Genesee Contact.—At the contact there is what locally appears to be a conformity between the brownish argillaceous Hamilton Shale below and the dark argillaceous Genesee Shale above. The dividing plane can only be located by determining where the Tropidoleptus carinatus fauna of the Hamilton is found and where on the other side Buchiola retrostriata appears, generally accompanied by Styliolina fissurella.

West of North Fork Mountain.—At Mouth of Seneca the Genesee, like the Hamilton and Marcellus, is mashed into contorted folds, with no fossils, and with the boundaries of the formations not distinct. The portion assigned to this formation consists of dark shale alternating with bands of dark sandstone, the thickness of which because of the contortion of the strata it is not possible to determine. It is sufficiently shaly to partake of topographic characteristics along with the Hamilton and the Marcellus, west of which it outcrops along the west side of the valley of North Fork, and,

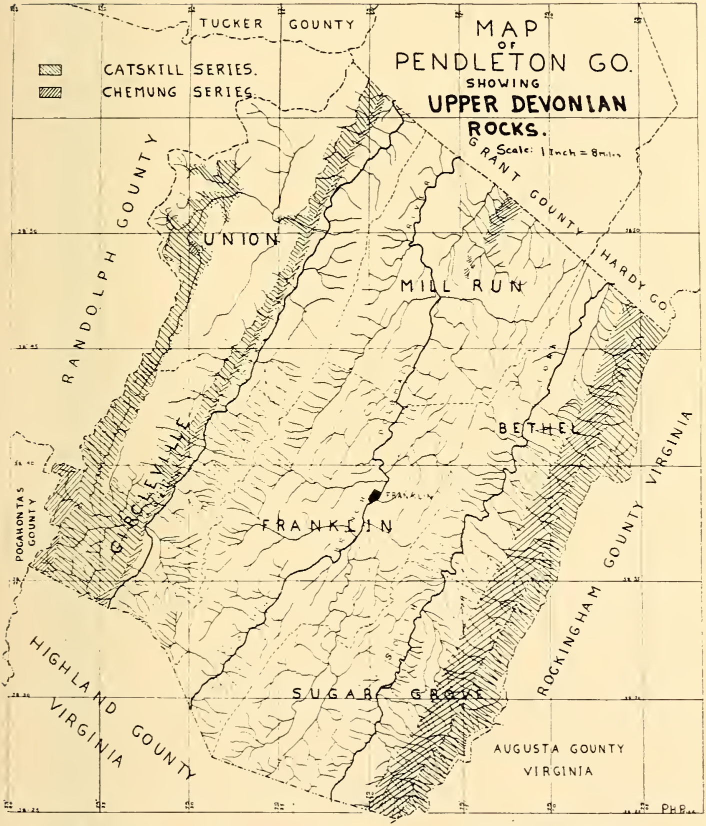

Figure 23.—Map of Pendleton County showing Upper Devonian Rocks.

dipping northwestward underneath later beds, does not appear again within the limits of the county.

East of North Fork Mountain.—Between North Fork Mountain and South Branch there are no Genesee strata, they having been completely eroded away. Where the Franklin-Petersburg highway crosses the county line the Genesee strata outcrop in a width of about two-tenths of a mile west of the road. The outcrop is crossed by the road about a mile south of the county line, south of which the Genesee is at an increasingly greater distance east of the road to a point about two miles east of Upper Tract, where the Genesee loops back along the east side of the Portage-Chemung area of the Middle Mountain Syncline. Along this side of its loop it lies about seven-tenths of a mile west of Mount Horeb Church and four-tenths of a mile west of Borror School.

East of South Fork River a narrow belt of Genesee lies immediately east of the Hamilton Shale clear across the county. Because of the characteristic fossils, Buchiola retrostriata and Styliolina fissurella, it is the most easily distinguished portion of the wide shale area of Sweedlin Valley and of the valley of South Fork River. At Bethlehem Church it lies four-tenths of a mile to the southeast. From a mile south of Oak Flat to the south county line it lies beneath or close to the river. It is in the point of high ground close to the road at and near the mouth of Heavener Run, and at Brandywine it is in the edge of the uplands just east of town. At this point occurs a good opportunity for a measurement, made by Paul H. Price. By pacing, the width of the outcrop was found to be 661 feet. This, with dip of 17° 15′ southeast, gives a thickness of 196 feet. At Lone Poplar School the Genesee lies two-tenths mile to the east, and at Oak Grove it is in the riverside due east. From near Wilfong School southwest to the county line it is chiefly on the west side of the river. At the State line the belt of Genesee is one-tenth mile wide and located a tenth of a mile west of Palo Alto. There are no other areas of Genesee strata to be found east of North Fork Mountain. East of the strip exposed along South Fork the Genesee lies deep in the ground beneath Shenandoah Mountain.

PLATE XLIII.—Genesee Shale at Brandywine. (Photo. by Paul H. Price.)

Paleontology.

Of the shells by which the Genesee strata can be recognized, one, Buchiola retrostriata, is a small convex pelecypod shell a third of an inch long and about as wide as long, with broad chevron-marked flat ribs extending from umbo to front on each valve. With such a shell is commonly associated Styliolina fissurella, which is a minute, narrow, cone-shaped shell about two-tenths of an inch long.

Locations.

No. 17.—At the north side of the road three-fourths mile northeast of Alt School, on the road to Petersburg, the question arose as to whether the outcrop was Genesee or Portage. In the shale were found the following fossils:

Lingula
Buchiola retrostriata
Paracardium doris
Paracardium delicatulum
Styliolina fissurella
Bactrites aciculus
Tornoceras uniangulare
Impressions as of young Paracardium or Buchiola
Plant impressions
Impressions as of trail of a crustacean or worm.

From such an assemblage it is certain that the shales are Genesee.

No. 18.—This collection was made at an excavation for a garage 0.6 mile from the bridge where the road to Petersburg crosses South Branch. The following forms were obtained:

Lingula
Paracardium doris (abundant)
Buchiola retrostriata
Bactrites aciculus
Tornoceras uniangulare
Pharetrella tenebrosa.

No. 58.—The following forms were found in Genesee Shale near Mount Hope Church on Deer Run, 1.7 miles southeast of Upper Tract:

Plant impressions
Lingula
Pterochaenia fragilis
Styliolina fissurella
Tornoceras uniangulare.

No. 59.—The following collection was made of quarter of a mile north of the mouth of Camp Run:

Impressions of plants
Buchiola retrostriata (many)
Lunulicardium encrinitum
Pharetrella tenebrosa
Bactrites aciculus
Tornoceras uniangulare.

No. 55.—This collection was obtained from beds near the base of the Genesee Shale a quarter of a mile east of Brandywine:

Buchiola retrostriata
Grammysia subarcuata
Pterochaenia fragilis
Styliolina fissurella
Tornoceras uniangulare.

No. 56.—This collection was obtained from beds near the middle of the Genesee Shale a quarter of a mile east of Brandywine:

Lingula
Buchiola retrostriata
Grammysia subarcuata
Lunulicardium encrinitum
Pterochaenia fragilis
Tornoceras uniangulare
A mark as of a trail of a crustacean.

No. 57.—This collection was obtained from beds near the top of the Genesee Shale a quarter of a mile east of Brandywine:

Plant impressions
Buchiola retrostriata
Pterochaenia fragilis
Trail as of a crustacean or worm.

No. 27.—This collection was obtained on the east side of the hill near the mouth of Stony Run, half a mile south of Sugar Grove. Here in the dark shale was found Buchiola retrostriata of the Genesee. In another fragment of the same collection was found Orthoceras subulatum and Chonetes

coronatus of the Hamilton. It is evident that the collection was made at the Genesee-Hamilton contact. (Collection No. 40 was obtained from the Hamilton a little to the east of the location where collection No. 27 was found).

No. 35.—This collection was obtained from the Genesee Shale at the mouth of Crummet Run, where it joins South Fork:

Buchiola retrostriata
Styliolina fissurella
Bactrites aciculus
Tornoceras uniangulare.

No. 33.—This collection was obtained 0.2 mile west of Palo Alto. 100 yards farther west Hamilton Shale was recognized **(No. 34)**, then Marcellus and Oriskany. To the east of the Genesee and near at hand was the Portage, the border line being 0.15 mile west of the road intersection. The Genesee at this point was found to contain an abundance of Buchiola retrostriata, Bactrites aciculus, and Styliolina fissurella.

The Genesee-Portage Contact.—This contact is conformable so far as local conditions are concerned. Below it are the dark Genesee Shales with their Buchiola retrostriata and Styliolina fissurella. Where these cease the Portage Shales begin. The Portage Shales are essentially non-fossiliferous. They are gray, thin-bedded, and arenaceous, the plane though conformable thus marking a great change in character of sedimentation, which doubtless was accompanied by a change in the attitude of the land mass to the east from which the material was derived or a change in the direction of transportation along the shore, probably a change in both. This contact plane thus separates two great masses of different strata: the

[3]It is not the intention of the writer to discuss the history of the nomenclature. These various Series have been grouped as follows:

Catskill	Hampshire Formation
Chemung Portage Genesee	Jennings Formation
Hamilton Marcellus	Romney Shale

Marcellus-Hamilton-Genesee dark clayey shale below, and the gray arenaceous shale and sandstone above, followed by reddish shale and sandstone: the Portage-Chemung-Catskill[3]. There is, however, somewhat of limestone in the Chemung, and interpolated clayey shale in the Portage.

PORTAGE SERIES.

(Map Symbol, Dp).

West of North Fork Mountain.—Near the western portion of the compressed strata beneath the flood-plain at the Mouth of Seneca is a belt of thin beds of fine gray sandstone alternating with a gray shale, no layer of sandstone being as much as two feet thick, set on edge, and without fossils. It is this portion that corresponds to the Portage, but as no definite contact with the Genesee can be determined upon its thickness has not been measured at this point. The sandstone layers though thin are numerous enough to produce more regularity in the folding than is to be found in the Marcellus and Hamilton, and its position close to the Chemung where there are thicker sandstone layers, joins it with that member in topographic expression.

Both northeast of Mouth of Seneca and southwest of that locality the Portage borders the eastern side of the high ground of Chemung strata. Toward the northwest it disappears beneath the overlying Chemung and does not reappear within the borders of the county.

East of North Fork Mountain.—Between North Fork Mountain and South Branch River there are no strata of Portage age. Where the Franklin-Petersburg road crosses the county line the Portage strata outcrop in a width of about a mile, dipping southeast. 0.9 mile still farther east is the eastern margin of the Portage dipping northwest, thus forming part of a synclinal area. These two limbs of the syncline extend southwest beyond Brushy Run and meet in the area just to the southwest of that stream.

East of South Fork River and just east of the strip of Genesee Shale, there is a belt of Portage sandstone and shale

about half a mile wide extending northeast-southwest across the county. With the exception of a strip from Wilfong Church southwest to Palo Alto the area is entirely on the east side of the river.

The contact between the Portage and the Genesee is easily observed, but there is no sharp line of demarcation visible for an eastern contact with the Chemung. Particularly is this so in the southern portion of the area where there are several thick beds of sandstone that are evidently within the Portage area, the entire eastern margin of which area is here involved in folds so that the Portage is here in a vertical position. Farther west and north the dip is from 20° to 40° southeast.

Along Rough Run the eastern margin is fairly definite, lying just west of a line from Cow Knob to Dug Knob, where the dip is 39° 30′ southeast. With an outcrop area here 0.8 mile wide this dip would indicate a thickness of 2674 feet.

Along the road from Brandywine toward Harrisonburg the eastern margin of the Portage is also fairly evident, but the Portage is involved in repeated folding to such an extent that no measurement of thickness is possible. Because of this folding the Portage here lies at the surface across a belt 1.75 miles wide.

While the western portion east of Sugar Grove has a dip to the southeast for 1.4 miles the eastern portion of the Portage is in an area that is greatly compressed and contorted, so that computation of thickness is here impossible.

Up Brushy Fork the contact is judged to lie beneath the stream at a point one-fourth mile south of Brushy Fork Church.

East of the above mentioned areas the Portage, dipping southeast, extends under the Chemung and Catskill strata of Shenandoah Mountain.

Paleontology.

Location No. 54.—Fossils in the Portage are very rare in this part of the State. The only place where any were found is near the mouth of Mill Run one mile east of Upper Tract. Here were found specimens of Ambocoelia umbonata and indistinct forms of Buchiola that seem nearest to Buchiola re-

trostriata. Of these Buchiola retrostriata is reported to have been found elsewhere near the base of the Portage and Ambocoelia umbonata as occasionally found in the upper part of the Portage (Parkhead).

Plant remains were not noted west of North Fork Mountain, in which region the Portage is compressed into steep folds, but in the northeastern portion of the county plant fossils are very abundant. Up Brushy Run fragments of stems appear along the road across the Portage area. They are particularly abundant in a field located close to the road in high ground two and a half miles in a straight line from the mouth of the run.

A mile east of Brandywine the yellowish Portage shale is iron-stained, as if plant remains had been present, and fragments of plant impressions are found in the bed of a ravine to the north. East of Sugar Grove there are plant remains exposed by the roadside, some of which fragments are of algae. The yellowish shales are iron-stained, as along Brushy Run to the north. Farther south just below Brushy Fork School, the Portage strata are involved in steep-sided folds, that are not favorable to the location of fossil remains.

Impressions and casts of logs have been reported both to the north in New York State and to the west and south by D. B. Reger in Randolph and Pocahontas Counties, but they have not yet been located in Pendleton County. Possibly they may be found when searched for. Possibly their preservation is related to conditions of erosion and of deposition prevalent in those regions of Portage beds. The Portage beds are exceptionally thick in the southeastern part of Pendleton County, as they are also reported to be in New York State and in Randolph County.

The Portage-Chemung Contact.—Evidently within the Portage there are one or more planes of erosion, for stumps of trees in New York State and logs in the Portage of Randolph County are related to old land surfaces. Possibly the thickening of Portage strata in southern Pendleton County is connected with broad relations that will yet be recognized and serve as a new basis in classification of these strata. At pres-

PLATE XLIV.—Portage Sandstones and Shales along South Fork River east of Wilfong Church. (Photo. by Paul H. Price).

ent there is no definite and satisfactory criterion for determining the Portage-Chemung contact. There was evidently a change in progress whereby a deposition of thin gray sandy shales and of thin sandstone beds was replaced by more uniform conditions under which thick beds of sandstone were deposited, with temporary deposition of calcareous beds. This contrast has been made use of in determination of relations in the northern part of the county, but in the southeastern part of the county the Portage itself contains thick beds of sandstone. This relation is further emphasized in the descriptions of both the Portage and the Chemung strata.

CHEMUNG SERIES.

(Map Symbol, Dch).

West of North Fork Mountain.—Where the highlands rise west of Mouth of Seneca is a width of 731 feet of heavily bedded grayish and reddish sandstone with accompanying reddish shale that is referred to the Chemung. It begins on the east with the first thick belt of a grayish sandstone 10 to 15 feet thick and extends without reversal of dip to the top of a conglomerate with flattish white quartz pebbles up to 1.25 inches in length, the strata dipping 67° 10′ northwest. The area is thus situated between an area of thin gray sandstones (Portage) on the east and of red sandstone and shale (Catskill) on the west. The conglomerate referred to is the only conglomerate in this portion of the strata. It is adjacent to shaly beds that seem to contain remains of weathered-out fossils and rounded flattened balls and twig-like forms. This horizon is judged to be that of the Hendricks Sandstone and Conglomerate. A tape line across the strike gave 731 feet. This for a dip of 67° 10′ northwest gives a thickness of 674 feet. The formation as a whole appears only in a low bank along the river. In this formation exposed along so narrow though continuous an outcrop no fossils were found. While in color it is chiefly gray it contains considerable reddish shale and sandstone, a color which is the predominating color of the Catskill Series.

Northeast from Mouth of Seneca the Chemung, with its resistant grayish sandstone, rises into the hills to form the range of high knolls that lie west of North Fork. The same is true southwest from Mouth of Seneca, the resistant layers, particularly the Hendricks, forming knobs along the eastern side of the higher ground occupied by the Catskill sandstone.

To the west the Chemung strata, like all the strata below it, disappear under later strata to the northwest and do not reappear within the limits of the county.

East of North Fork Mountain.—Between North Fork Mountain and South Branch River there are no Chemung strata. Between one mile and two miles southeast of the point where the Franklin-Petersburg road crosses the county line there is an area of Chemung strata 0.9 mile wide that extends along the axis of Middle Mountain Syncline, southwestward to just beyond Brushy Run.

East of Brandywine there is not a clearly defined base for the Chemung, but assuming the base to lie where the first heavy beds of sandstone are seen, the base is at a point 2½ miles southeast of Brandywine, where the level 1841 feet A. T. is established. The dip is here southeast. This direction it maintains though gradually becoming less in amount to the top of the mountain. Unfortunately the variations in the dip are such that a satisfactory determination of thickness is not here obtainable.

The Chemung is at the surface in a broad area along the west side of Shenandoah Mountain, its resistant ledges protruding in the divides between the various runs, imparting a ruggedness to this belt of topography.

Strange as it may seem the conglomeratic portion of the Hendricks Sandstone has not been detected along Rough Run, but the data for Chemung and Catskill combined are obtainable. Here the combined thickness of the two is 7665 feet. From this subtract the thickness of the Catskill (2800 feet) ascertained along the road east from Brandywine where the Hendricks is well exposed, giving a difference of 4865 feet as the thickness of the Chemung.

About 129 feet below the top of the Hendricks is a bed of sandstone containing three beds of white quartz conglomer-

ate separated from the denser Hendricks above by a bed of shale. The question occurs as to whether this conglomerate is the Lackawaxen Conglomerate, but there is no way to answer the question at present. There is no lower bed of conglomerate below the beds mentioned, and at this point there are no fossiliferous horizons such as occur farther north and west. The nearest fossil horizon found is at a point 1.4 miles up Camp Run, where the Chemung is well exposed. East of Sugar Grove a sandstone that contains coarse sand may possibly represent this conglomeratic horizon. A computation based on dip of beds and distance horizontally between outcrops places this bed 89 feet below an outcrop that is at the base of the Hendricks. East of Sugar Grove the Portage-Chemung contact, not well exposed, lies in the eastern margin of an area where the strata are folded and contorted, so that a determination of thickness in this area also is not possible.

Paleontology.

The Chemung fauna is characterized by the presence of Spirifer disjunctus, a large brachiopod with projecting hinge-line and with fine ribs occupying both the lateral portions of the shell and the large lobe and sinus. With Spirifer disjunctus may also be found Spirifer mesastrialis, Atrypa spinosa, Atrypa hystrix, Leptodesma medon, and Dalmanella tioga, along with other forms of brachiopods and pelecypods and fragments of crinoid stems.

Location.

No. 61.—The location selected for collection is on the south-facing slope of a lobe of Shenandoah Mountain situated on Camp Run at a point 1.7 miles from its mouth. Here the following were collected:

Crinoid stems
Bryozoon-like impressions
Douvillina cayuta
Spirifer mesastrialis

Spirifer disjunctus
Atrypa spinosa
Palaeoneilo plana
Pterinea chemungensis
Euomphalus
Platyceras marylandicum.

This assemblage does not make it clear just where in the Chemung the collection was made, but it is to be noted that Spirifer mesastrialis is not reported above the upper conglomerate, and that Atrypa spinosa is said to be found more commonly in the lower than in the upper Chemung.

In the description of the Chemung mention was made of the presence of plant remains in the Hendricks Sandstone. No special collection was made of them.

The Chemung-Catskill Contact.—This is taken at the top of the Hendricks Sandstone. If the collections of fossils for the Report on Mineral and Grant Counties were from the Hendricks Sandstone as supposed the sandstone in those counties is definitely allied with the Chemung. It should be noted, however, that associated with the Hendricks Sandstone there are fragments of twig-like forms, and, further, that while the sandstone is chiefly gray in color it contains considerable reddish shale and sandstone, and that it lies between two masses of reddish shale, all revealing conditions related to the Catskill. This further emphasizes the interfingering of Chemung and Catskill beds, and reduces the importance for determination of an exact dividing plane where there is oscillation between marine and terrestrial conditions of deposition.

CATSKILL SERIES.

(Map Symbol, Dck).

West of North Fork Mountain.—Just west of the Hendricks Sandstone near Mouth of Seneca the Catskill reddish sandstone and shale are compressed into several unsymmetrical folds, dipping on the whole to the northwest, but with such folding that satisfactory measurement is here impossible. Farther west in the county the customary reddish color of shale and sandstone so pronounced in Catskill strata can not

be relied upon to differentiate between the Catskill and the Pocono above it because red shale and sandstone are found scattered through the Pocono of this region. There is, however, a marked contrast between the two formations. The base of the Pocono is marked by a ledge of conglomerate of small rounded quartz pebbles, and other beds of conglomerate are found in all parts of the Pocono. West of Mouth of Seneca the Catskill strata, at first steeply folded and then farther west dipping at a low angle, form the lower sides of the mountain along the road west to where the Catskill disappears beneath the river a few yards below the cement bridge half a mile south of Onego. Toward the west it remains beneath the level of the river along the trough of a broad gentle syncline, appearing above the level of the river again a mile and a half west of Onego. From here on the rise of the strata carries the Catskill well up the mountainside, but the rise is not sufficient for the Chemung to appear in the river trench, since the stream has a steep gradient. Thus in the lower courses of all tributaries west of the syncline the reddish shales and sandstones to be seen are of Catskill strata.

To the northeast of Mouth of Seneca the folded portion of the Catskill with its massive reddish sandstone rises into ridges of high knobs, flanked on the east by ridges of Chemung and on the west by the even more resistant Pocono. To the northwest of this portion of the county the Catskill disappears beneath Smith Mountain.

South of Mouth of Seneca the high range of Catskill hills is continued southwest to the State line. South of Big Run the area occupied by the Catskill widens out, so that it forms all of Big Mountain. The lower course of Big Run lies essentially parallel to the strike of the strata to near its mouth, where the stream cuts across the steeply inclined Catskill and Chemung strata to join North Fork. In the upper part of its course the main creek and all of its tributaries lie on Catskill strata for a distance of two and a half miles along the eastern limb of the broad syncline that continues southwest beyond the Hunting Ground area. The same relation is to be noted up Vance Run though changes are not so marked as along Big Run. The upper limit of the Catskill is considered to be the

lower ledge of conglomerate that marks the base of the Pocono. In no part of this area is the full thickness of the Catskill easily obtainable because of the folding along the eastern margin. Farther west where the strata flatten out the base of the Catskill is not exposed. Near the mouth of Big Run the base of the Catskill is at stream level (1750 feet A. T.) 0.2 mile northwest the top is placed at 3000 feet A. T. This gives a thickness of 1273 feet, an estimate that seems remarkably thin compared with the greater thickness of 2800 feet found in the eastern part of the county along Shenandoah Mountain.

East of North Fork Mountain.—Through the central portion of the county the Catskill strata are not present (removed by erosion), but in the eastern portion of the county it forms the great mass of the upper portion of Shenandoah Mountain in all but the highest knobs.

As already stated the base of the Catskill is taken at the top of the heavy bed of sandstone and conglomerate known as the Hendricks. This ledge of sandstone may be seen well up the mountainside east of Brandywine, where the top of the sandstone is crossed by the 2550-foot contour. At this ledge the dip is 37° 15′ southeast. From this point on to the saddle where the road from Brandywine crosses the divide there are seven heavy masses of reddish-brown sandstone, the fourth from the bottom somewhat shaly, much of it so cross-bedded that determinations of dip are of little avail except to indicate that the dip is southeast and that it gradually becomes less until at the crest of the divide it is zero, the dip on the east side of the divide being in the opposite direction (northwest). Above the level of the saddle where the road from Brandywine crosses the divide is still another mass of similar sandstone toward the base of High Top. It is the top of this sandstone at 3750 feet A. T. that is thought to mark the top of the Catskill. These facts give all that is necessary for the determination of the thickness. When drawn to scale the thickness is found to be 2800 feet.

On the Shenandoah Mountain east of Sugar Grove the Hendricks Sandstone at the base of the Catskill is at an altitude of 2825 feet A. T., with dip of 25° southeast. The dip

gradually diminishes until at the crest of the mountain it is zero. The topmost beds assigned to the Catskill lie at 3950 feet A. T., and the horizontal distance between the points measured at right angles to the strike is 7920 feet. A determination of the thickness of the strata under these conditions gives 2880 feet as the thickness of the Catskill.

Paleontology.

The red beds of the Catskill are non-fossiliferous. A thin layer of dark shale that contained a few lingulas and evidences of plant life has been reported found not far below the top of the Catskill, but that horizon was not located along Shenandoah Mountain.

The Catskill-Pocono Contact.—This plane lies between the heavy beds of reddish sandstone and shale of the Catskill Series, with their evidence of arid conditions, without the presence of beds of conglomerate near the top, and the succeeding Pocono beds with their alternation of red beds and beds of conglomerate containing small pebbles. This particular horizon may be seen on the north side of Seneca Creek a quarter of a mile below the cement bridge which is half a mile southeast of Onego. Here there is a ripple-marked grayish sandstone beneath a ferriferous shale that contains indications of plant remains, and above this a ledge of quartz conglomerate with pebbles up to an inch in diameter.

These conditions indicate a change from a low-lying arid region to marine conditions in which we have the strand deposits of sand and gravel preserved. Such a return without evidence of differential crustal movement presents an "evident disconformity" at the margin of an overlap.

THE MISSISSIPPIAN SYSTEM.

	Feet.
The Mauch Chunk Series: below, brownish and grayish sandstone and shale with beds of limestone, fossiliferous; above, sandstone and shale with many plant fossils..	1722
The Greenbrier Series: limestone, bluish and heavily bedded below, reddish and arenaceous beds with limestone above....................................	399

	Feet.
The Pocono Series: sandstone, cross-bedded, grayish, conglomeratic, and shales, 215′ to	345
Total	2466

Figure 24, page 179, prepared by Paul H. Price, shows the areas of Pendleton County in which the Carboniferous Rocks (Pottsville, Mauch Chunk, Greenbrier, and Pocono Series) outcrop. In greater detail, these same areas will be found on Map II accompanying this Report in a separate Atlas.

THE POCONO SERIES.

(Map Symbol, Cpo).

West of North Fork Mountain.—The change from the reddish-brown sandstone and shale of the Catskill to the grayish-brown micaceous cross-bedded conglomeratic sandstone at the base of the Pocono can be noted about a quarter of a mile below the cement bridge which is half a mile southeast of Onego. At the base of the Pocono is a fine-grained ripple-marked grayish sandstone about a foot and a half thick. Next above is a ferriferous shale about two feet thick with faint indications of plant remains, then a heavy mass of conglomerate with rounded quartz pebbles mostly a third of an inch in diameter lying in sheets. A few larger pebbles may be noted up to an inch in diameter. The whole cliff rises to a height of twenty-five feet above the stream. Above this ledge it is somewhat shaly for a number of feet beneath a second heavily bedded sandstone the top of which is sixty feet above the top of the first ledge by the creek. Likewise, further shaly sandstone extends up to a third heavily bedded sandstone the top of which is eighty feet above the top of the second. An additional fifty feet of sandy shale largely concealed in this locality reaches the basal limestone of the Greenbrier.

As measured by barometer northeast along the strike from the creek bed near the cement bridge the entire thickness of the Pocono is thus 215 feet in this locality, and contains three prominent ledges of grayish-brown sandstone, the lowest

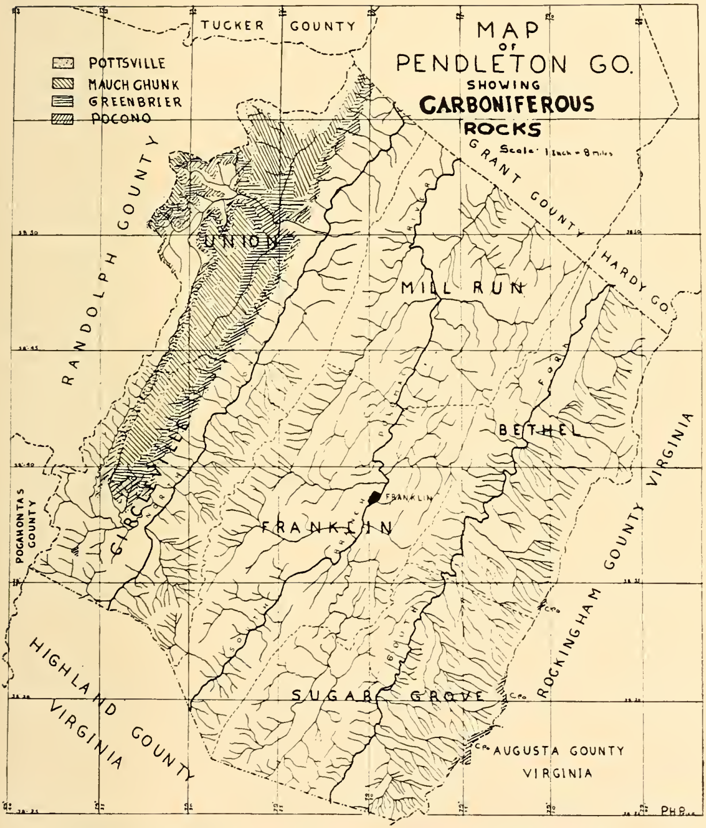

Figure 24.—Map of Pendleton County showing Carboniferous Rocks.

of which is here conglomeratic and lies upon a thin bed of slightly fossiliferous shale. East of Smith Mountain the Pocono lies with uniform strike northeast to the limits of the county. Its general dip is northwest under Smith Mountain and Roaring Plains. Along Roaring Creek to the west of Smith Mountain it is the second of the sandstone beds that appears in the hillside just west of the mouth of the creek, the other members appearing along that creek within 0.8 mile to where the base of the Greenbrier Limestone is crossed by the bed of the creek.

On the hillside a mile northwest of Onego five distinct beds of conglomerate were noted in the Pocono of that locality, and at numerous places cross-bedding is a common feature where these reddish sandstones appear along the hillside. Along Seneca Creek the Pocono is well exposed for a mile and a half across the axis of a broad syncline, and then, farther west, it is exposed higher up in the lobes along the various tributaries northwest of the county line. To the southwest it appears along the various tributaries that drain the region west of Spruce Mountain.

Southwest from Mouth of Seneca these resistant fine-grained reddish conglomerates and sandstones overlying the Catskill sandstones and distinguished from them with difficulty, form the high jagged cliffs near the heads of ravines to the west of North Fork, as at Tanyard Gap, Bennett Gap, and Pound Mill Run. In the area to the southwest of Hunting Ground they are present and along valley sides over a wide area in extension of the broad syncline upon which rises Spruce Knob, the highest mountain in the State. West of the axis of this syncline the eastward dip is so slight that the broad area of Pocono is at the surface across Grassy Mountain to the Allegheny Mountain at the most western point of the county.

It is noted that the Pocono here consists of three distinct beds of sandstone the lowest of which is distinctly conglomeratic, and the topmost portion is a reddish shaly sandstone which weathers into soft shale. In other places the following names are applied to the Pocono oil sands from the base up: Berea, Weir, Squaw, Big Injun, with the Keener and Beckett

Sands considered as portions of the Big Injun. Just how the sandstones of western Pendleton County are related to the oil sands named it is impossible to state, though it seems probable that the basal member at the cement bridge near Onego is the Berea. Neither is it possible to affirm that the topmost shaly sandstone is the Maccrady. So far as can be detected the topmost beds of the Pocono are continuous, the erosion that followed their deposition leaving a surface that was a plain. The non-evident disconformity that exists has only reddish shale to mark the horizon at which the Maccrady of the southern part of the State is reported[4] to be 2000 feet thick. This time of erosion was followed by subsidence during which the heavy limestone beds of the Greenbrier were laid down.

East of North Fork Mountain.—East of North Fork Mountain the Pocono is not encountered until the crest of Shenandoah Mountain is reached, where some of the highest portions are capped by a resistant light-colored sandstone composed of well-rounded grains of white quartz (Purslane Conglomerate). Such portions have in the course of events been so located that they were not subjected to stream action, but long-continued weathering has affected them, changing the finer iron-bearing matrix of the upper sandstones to a yellowish-brown color. At High Top southeast of Brandywine, frost action has left the mountainside strewn with loose angular fragments of large size, forming a steep talus for nearly two hundred feet, the lowest portion of which, composed of smaller rock fragments pushed along in storms as occasion has permitted (slide rock), is now covered with thin soil that supports a growth of trees and bushes. All the lower saddles and ridges consist of Catskill sandstone.

At an elevation of 3750 feet A. T. is a lobe of grayish sandstone with plant remains (strap-shaped leaves) that, at the end of the bench, seem little removed from their original location. Without definite information as to exact level of the base of the sandstone, this level of 3750 feet is assumed to mark approximately the base of the Rockwell at this point. Some-

[4]D. B. Reger, West Virginia Geological Survey, Report on the Geology of Mercer, Monroe, and Summers Counties.

where within the talus is a ledge of conglomerate with white rounded quartz pebbles half an inch in diameter, for fragments of it are to be seen in the lower talus. The white conglomerate with large pebbles clearly belongs to the Purslane, beneath which the buff sandstone of the Rockwell is located, as revealed farther north as well as here. The Purslane fragments were found near the base of the heavy talus (at about 3830 feet). Some portion of the Purslane Conglomerate is then above this level. At 4035 feet is a white sandstone in a ledge which, though broken, seems in place. This is judged to belong to the Purslane. At the top also the sandstone with small rounded grains of quartz cemented by what is now a light yellowish matrix, stained by weathered iron in what evidently was originally a white sandstone, is also a part of the Purslane. On this basis the brownish thin-bedded sandstone up to a level of 3750 feet is referred to the Catskill, all from 3750 to somewhere near 3900 is referred to the Rockwell, and all above that level to 4107 feet, the top of the mountain, is referred to the Purslane. While the boundaries are not exposed it is believed this estimate is worth while and close to the correct relation.

Section at High Top.

	Feet.
Purslane: Approximately 207 feet thick, to the top of the knob, which is at 4107 feet A. T.	
Sandstone with small rounded grains of white quartz cemented by light-yellowish matrix containing a little hydrated oxide of iron.	
Base of exposed portions of ledge of white sandstone with small rounded grains of quartz, at 4035 feet A. T. Some of the upper sandstone is finer in texture than that in lower portion. Approximate base of Purslane at 3900 feet A. T.	207
Rockwell: Approximately 150 feet thick.	
Talus of loose angular blocks of sandstone for about one hundred feet; at lower levels there is thin soil except in lines of storm drainage, the soil supporting a growth of trees and bushes, to base of High Top, which is at 3830 feet A. T.	
Sandstone, grayish; plant remains, strap-shaped; assumed base of Rockwell at 3750 feet A. T.....	150
Total....................................	357

Catskill:

Sandstone, thin-bedded, brownish red, to level of saddle north where road from Brandywine to Harrisonburg crosses the Mountain, at 3440 feet A. T. (This saddle is not at the base of the Catskill).

At Shenandoah Tower on the crest of Shenandoah Mountain east of Sugar Grove, the change from reddish cross-bedded Catskill sandstone to a light brownish-gray Rockwell Sandstone takes place at an altitude of 3950 feet A. T., and the change to a white Purslane Sandstone composed of rounded white quartz grains cemented by quartz, takes place at an altitude of 4295 feet A. T. At the crest of the mountain by the lookout tower the quartz grains are evident. The weathered character of the matrix imparts a yellowish-gray shade of color to the rock as a whole, but it is not so fine-grained a sandstone as that at the top of High Top. At Shenandoah Tower the thickness of the Purslane is thus taken as 50 feet, and the thickness of the Rockwell as 345 feet. Here the strata are horizontal, in the axis of an immense syncline.

There is no trace of Hedges Shale above the Purslane. Conditions that have left the crest of Shenandoah Mountain as it is now would long since have removed any trace of Hedges Shale that may have existed here. In Hampshire County it has remained where protected in a syncline of Purslane Sandstone. We must look to the west side of Pendleton County for the presence of higher strata.

Questions of Correlation.—A comparison between the Pocono of the eastern part of the county and that of the western part presents contrasts. The base of the Pocono in the eastern part of the county contains strap-shaped leaves, above which is a pronounced conglomeratic portion, followed upward by other sandstones that in places are conglomeratic. Large portions of the Pocono in the western part of the county thus correspond in texture to the Purslane of the eastern portion of the county, while the Rockwell of the eastern portion of the county is represented in the western portion by an horizon of plant remains marking at least the close proximity of a soil horizon, and thus chiefly the horizon of a disconformity. In the east the Rockwell is judged to mark a condition of deposi-

tion gradually changing from that giving cross-bedded reddish-brown sandstone of oxidized material (Catskill), through a condition of less oxidation (Rockwell) and less terrestrial than found in the western part of the county, to conditions in which siliceous sandstones and conglomerates were formed both in the eastern and the western portions of the county, but the sandstones in the western portion are now chiefly reddish-brown, like Catskill strata, while those in the eastern portion are now a whitish sandstone, more gritty and with less iron, a distinction that is clearly due to a difference in deposition, not due to later weathering on exposure to air. Whether this difference in conditions of deposition was accompanied by the presence of a partial barrier between the two locations the local conditions do not inform us. Following the deposition of the Rockwell, similarity of conditions is partially resumed, as indicated by the finer grain of the sandstone and the greater proportion of oxidized material in both portions of the county. To the west, wind and water gave sheets of cross-bedded strata along a shore, a wide-spread fine-grained cross-bedding referred to wind action being evident. This same structure may be noted in the finer deposits of the uppermost beds of the Purslane as seen at Shenandoah lookout tower. During the time of deposition of these beds, conditions of deposition were essentially the same in the eastern part of Pendleton County as in the western portion.

In the eastern part of Pendleton County there is no Hedges Shale left above the Purslane, as found in Double Mountain in Hampshire County, and in Morgan and Jefferson County farther northeast. It seems necessary to assume that the Hedges Shale of these eastern counties was laid down contemporaneously with deposition in the western part of the county or laid down locally in the general interval of erosion that preceded the depression and the deposition of the great beds of limestone (Greenbrier).

The Pocono, the uppermost formation in the eastern part of the county, was involved in the folding that affected the entire region later, and all overlying strata that may have been deposited there have since been removed by erosion.

PLATE XLV.—Pocono Conglomerate along Seneca Creek at bridge south of Onego. (Photo. by Paul H. Price).

Paleontology.

The only fossils that were noted in the Pocono are the indications of plant remains found near the base of the Pocono three-fourths of a mile southeast of Onego (Collection **No. 62**) and the strap-shaped leaves found at 3750 feet A. T., on the flank of High Top.

The Pocono-Greenbrier Contact.—The strata change from shale and conglomerate below to limestone above the plane of contact. How uneven the surface of the Pocono really was before the subsidence occurred that led first to the deposition of shale and then to that of limestone it is impossible to state from relation of beds seen in a comparatively small area of the county. So far as can be determined the surface was not very uneven. On subsidence one would expect shale to be laid down prior to the deposition of the great beds of limestone (Greenbrier). The shale (red) that has been seen at this horizon is not fossiliferous, so that it has not been possible to tell from fossils what portion of the reddish shale belonged to a weathered surface of old beds and what portion, if any, were the first beds laid down as subsidence proceeded. In this interval in Mercer, Monroe, and Summers Counties, Mr. Reger reports fully 1500 feet of strata that are not present in Pendleton County. The reddish and clayey character of the beds that remain certainly ally them with the Pocono rather than with the basal beds of the Greenbrier. Consequently the top of these shales is regarded as the weathered top of the Pocono (Maccrady?), and the contact plane is considered to lie at the base of the calcareous beds of the Greenbrier. Since no difference in dip between the beds above and those below the contact has been noted, the contact is considered that of a great "evident disconformity". It is clear that the Pocono was subject to erosion until the limestone beds above (the Fredonia of the Tennesseean division of the Mississippian) were laid down. In that interval the beds of the St. Louis Limestone of the Mississippi Valley and of southern West Virginia were laid down.

THE GREENBRIER SERIES.

(Map Symbol, Cgr).

West of North Fork Mountain.—The Greenbrier is best exposed along Roaring Creek from the mill 0.9 mile north of Onego to the mouth of Elklick Run, where the uppermost beds of the Greenbrier disappear beneath the bed of the creek and the lowest beds of the Mauch Chunk appear in the mountainside. The general direction of the creek is along the strike of the strata on one side of a broad syncline the axis of which lies about three-fourths of a mile west of the creek. There is, however, a little unevenness along the strike, the strata plunging slightly both northeast and southwest from Roaring School, but the Pocono sandstone, once it disappears beneath the bed of the creek at the mill, does not reappear[5] up the stream.

The Greenbrier Series lies in three main divisions, counting the topmost shale as a part of the uppermost division. A fourth division may also be recognized if the lowest division is considered separated into two parts by the ten feet of shale 115 feet above the base. This shale is here considered to be one phase in the change from massive limestone below to an alternation of limestone and shale above in the same, the lowermost (Gasper, or Upper Union) division.

The massive character of the basal ledges 115 feet thick is a prominent feature wherever this portion of the Greenbrier outcrops. It stands in marked contrast with the reddish and grayish shaly Pocono below, and with the 184 feet of alternating beds of blue limestone and various colored shale above. Where examined none of these beds appeared to be especially fossiliferous.

The basal member (Fredonia) of this thick limestone series is not distinctly separated from the other thick beds immediately above. It is not the laminated cross-bedded sili-

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[5]The Franklin Folio incorrectly represents the Pocono as coming to view twice near the mouth of Long Run. The Cypress, the reddish shale of the Glen Dean Limestone above, and the lowest shales of the Mauch Chunk are the beds crossed by Roaring Creek near the mouth of Long Run.

ceous limestone such as is found farther northwest, nor is there a distinct Rosiclaire present, such as is found in both the southern and the northern parts of the State. As no distinct evidence of a local disconformity has been detected, the conditions for deposition of limestone are thought to have remained continuous in this portion of the State. The upper part of this division (Gasper, Upper Union) is the main quarry rock in the Greenbrier of the northern part of the State.

The Cypress division, which is the second division coming immediately above the Gasper, consists of a mass of sandy shale 46½ feet thick.

The third division, Glen Dean or Alderson Limestone together with a bed of shale possibly 46 feet thick, lies immediately above the Cypress. The limestone is a bluish cherty fossiliferous limestone seven feet thick. Half a mile above Roaring School the limestone contains two thin layers of hematite and at the top several partings with plant-like remains one of which is a distinct Lepidodendron. This ledge is remarkable in Roaring Creek for the springs that issue from it along the mountainside. Several occur near Roaring School, and within a quarter of a mile north of the school, a considerable volume of water gushes from the mountainside. The contact with the Cypress below may be seen on the west side of the creek at a point 0.2 mile above Roaring School.

Neither the Cypress division nor the Glen Dean division is recognized in the northern part of the State.

These various members of the Greenbrier Series here found in Pendleton County all belong to the uppermost division (Tennesseean) of the Mississippian, so that now it looks as if the surface of the Pocono had been subjected to erosion through all the interval of time during which in the Mississippi Valley Waverlyan above the Pocono and the lowest division (Iowan) of the Tennesseean were being deposited.

Roaring Creek passes over all of the subdivisions of the Greenbrier in a distance of two and a half miles from near the mouth of Long Run south to the mill. In ordinary summer weather the water passes down into crevices in the limestone, leaving the creek bed dry for about a mile, then reappears gushing from the mountainside, to flow through a

flume to the mill. A similar arrangement is noted at a mill on Brushy Run.

The ravine along which the strata were measured by means of both hand-level and barometer is located on the east side of Roaring Creek about a quarter of a mile above the mill already mentioned.

The Greenbrier Series.

	Feet.
Glen Dean, Alderson: (53 feet)	
Shale, largely concealed	46?
Limestone, bluish, cherty, fossiliferous (Sample No. 8)	7
Cypress: (46½ feet)	
Shale, sandy, concealed in ravine where section was measured but exposed farther north along the creek	46½
Gasper, Upper Union; Fredonia at base: (299½ feet)	
Limestone, dark, heavily bedded, top conglomeratic (Sample No. 7)	15
Shale, dark, calcareous	13
Limestone, blue, solid ledge	5
Limestone, blue and gray, various thicknesses with shaly partings	20½
Limestone, blue, thick ledge	3
Limestone, reddish and gray, thin-bedded	34
Concealed, apparently shaly and reddish limestone (Sample No. 6)	26
Limestone, blue, with six prominent layers	26
Limestone, thin-bedded (Sample No. 5)	21
Limestone, blue, thick- and thin-bedded, containing a limestone conglomerate (Sample No. 4)	11
Limestone, reddish, shaly	10
Limestone, blue, dense (Sample No. 3)	15
Limestone, reddish, shaly	11
Limestone, blue, heavily bedded (Sample No. 2)	48
Limestone, bluish, heavily bedded, to base at mill (1890 feet A. T.) (Sample No. 1)*	41
Total	399

East of Roaring Creek the Greenbrier Limestone outcrops in a long belt part way up the east side of Smith Mountain and on farther north to the Grant-Pendleton County line. West of Roaring Creek it forms a belt at first but 150 feet above Seneca Creek at Onego School three-fourths of a mile

*For analyses of these samples, see table of analyses of limestones, numbers 23 to 30.

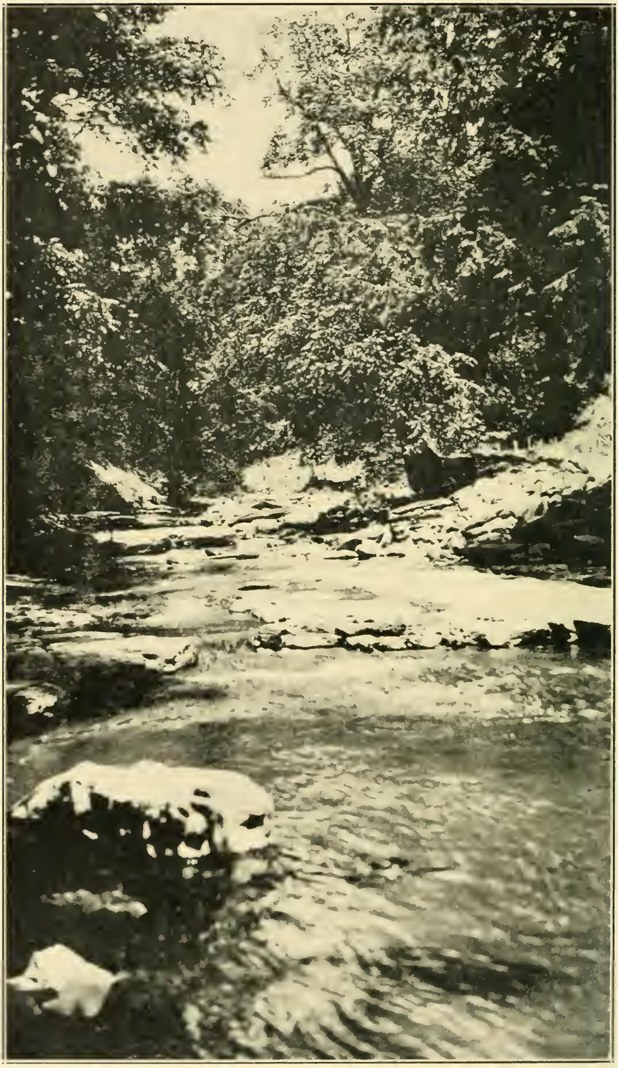

PLATE XLVI.—Water in Roaring Creek flowing over Cypress Sandstone at Roaring School. (Photo. by Paul H. Price).

west of Onego, and then at higher levels along Hoffman Ridge to the county line, for the strata rise in that direction. To the south it forms the valley sides of Brushy Run for four miles to a point west of Timber Ridge where the stream crosses the topmost layers. It also outcrops high in the valley sides of the upper course of Seneca Creek west of Spruce Mountain. South of Onego the limestone outcrops along the sides of Timber Ridge and Spruce Mountain, these eastern and western areas uniting south of Spruce Mountain to form the broad limestone area of Hunting Ground. In the entire synclinal area of Roaring Plains, Smith Mountain, Timber Ridge, and Spruce Mountain, the Greenbrier Limestone lies deep in the ground, these areas having younger strata (Mauch Chunk, or Mauch Chunk and Pottsville) above the Greenbrier Limestone. To the southwest of these areas the Greenbrier is entirely absent, the Pocono being the uppermost formation.

East of North Fork Mountain.—The Greenbrier is not present.

Paleontology.

As indicated in the previous description, the lower members of the Greenbrier, not found distinctly fossiliferous, were studied along the massive wall exposed east of Roaring Creek. The material is fine-grained and in part siliceous, presenting to view a few crinoid stems and an occasional Composita. In the Glen Dean the evidence is more frequent. Here the presence of a fragment of Lepidodendron was noted but no collection was made.

From work done elsewhere it has been found that the most common fossils to be expected are as follows:

Glen Dean:

- Pterotocrinus
- Pentremites (several species)
- Archimedes laxus
- Eumetria costata
- Orthotetes kaskaskiensis
- Productus ovatus
- Diaphragmus elegans
- Pustula
- Martinia contracta
- Composita trinuclea

Cypress:
- Archimedes confertus
- Other Bryozoa

Gasper—Upper Union:
- Campophyllum gasperense
- Zaphrentis spinulifera
- Pentremites pyramidalis
- Proterocrinus menardensis
- Fenestella
- Productus ovatus
- Diaphragmus elegans
- Orthotetes keokuk
- Spirifer pellaensis
- Composita trinuclea
- Martinia
- Bulimorpha
- Euomphalus
- Bellerophon
- Cephalopods
- Griffithides.

The Greenbrier-Mauch Chunk Contact.—The contact plane lies between the fifty-three feet of Glen Dean Limestone with its overlying oxidized shale, and the calcareous Lillydale Shale (See Collection **No. 63**). Here, in the sudden change from a limestone (Glen Dean) and its associated oxidized shale to the calcareous Lillydale Shale that follows, there is a marked break in the fauna, the change both in strata and fauna giving evidence of a disconformity. The presence of the disconformity is emphasized farther north in the State where the Lillydale Shale is a black carbonaceous shale with the same kinds of fossils as here but with the black shale resting not on Glen Dean but on Gasper Limestone.

THE MAUCH CHUNK SERIES.

(Map Symbol, Cmc).

The base of the shale that constitutes the lowest division of the Mauch Chunk is at the level of Roaring Creek about half a mile below the mouth of Long Run, where it has a thickness of about 12 feet. It is not there well exposed, and the upper portion, there a reddish and grayish arenaceous shale, failed to yield fossils at this point. On the hillside one mile southwest of Onego this same shale yielded an abundance of Allorisma

clavata, associated with Orthotetes kaskaskiensis, Productus ovatus, Zaphrentis spinulosa, and crinoid stems. This portion is known as the Lillydale Shale.

Above this Lillydale Shale are 80 feet of shale and limestone, highly fossiliferous (Glenray), that is well exposed in the end of the divide between Long Run and Elklick Run close to Roaring Creek. In the lower half of this exposure there are four beds of limestone the uppermost of which is ten feet thick. In the associated shale there is an abundant fauna in which shells of Orthotetes kaskaskiensis are numerous, associated with Composita subquadrata, Spirifer pellaensis, Productus ovatus, and Diaphragmus elegans. Above the ten-foot limestone the shale with thin layers of limestone is not well exposed.

Above the Glenray Limestone and Shale is a thirty-foot ledge of brownish cross-bedded sandstone (Webster Springs), which may be traced easily to where its base disappears beneath the bed of Long Run 0.9 mile above the mouth of that stream.

The base of the next heavy bed of sandstone (Bertha or Droop) thirty feet thick, is 191 feet above the top of the Webster Springs Sandstone. Between these two beds of sandstone there are two beds of limestone, the base of the lowest being 60 feet above the Webster Springs. To this entire sequence is given the name Reynolds. The lowest limestone is bluish in color and very fossiliferous. In this limestone and in the shale above it are found Orthotetes kaskasiensis in abundance, so abundant that the zone may be recognized as the Orthotetes zone. With Orthotetes are associated Spirifer pellaensis and Composita subquadrata. This lower limestone is ten feet thick, and the overlying fossiliferous shale, 20 feet thick. The upper of the two beds of limestone forms a massive ledge 10 feet thick. It is not especially fossiliferous where exposed. Long Run crosses the topmost ledge of the Reynolds one and a half miles west of where it crosses the base of Webster Springs Sandstone.

At 2800 feet A. T. up Long Run and in a direction N. 62° E. from Haystack Knob there is in the bed of the run an outcrop of the blue fossiliferous Reynolds Limestone about a

foot thick that contains Productus ovatus, Diaphragmus elegans, Orthotetes kaskaskiensis, Spirifer pallaensis, Composita subquadrata, Bellerophon sp., and an Orthoceras.

About half a mile below where Long Run crosses the Reynolds Limestone is a great mass of detritus left in flood time as a delta or alluvial cone at the mouth of an unnamed creek along which it is said a landslide had occurred a few years previously. Along this steep gully in the mountainside everything is exposed up to a short distance below the massive conglomerate that is taken as the base of the Pottsville Conglomerate. First above the Bertha Sandstone appears shale and sandstone of a reddish color for 120 feet, the topmost beds of the Hinton Group. Following a twenty-foot bed of reddish-brown sandstone (Hinton of Stevenson) the reddish shades of sandstone and shale continue for 600 feet to grayish sandstone and dark shale associated with thin seams of coal. The dark shales and gray sandstones continue for an additional 260 feet to the base of a light-colored sandstone considered the Princeton Sandstone, the base of which is at the top of the Hinton Group.

The black shale and thin coal continue for a distance of 83 feet above the top of the light-colored Princeton Sandstone to another whitish sandstone 10 feet thick. After thirty feet more of a gray shale there are only scattering indications of the presence of Mauch Chunk Shale for a distance of 80 feet, the top of which is considered to lie at 4400 feet A. T. Above this level there are fragmental blocks and a talus of Pottsville Conglomerate for 160 feet.

The section is recorded more in detail in the following Mauch Chunk Section along Long Run. From the base of the Pottsville Conglomerate down to the Bertha or Droop Sandstone the record is obtained from the steep landslide ravine or run just described. The portion relating to the Bertha or Droop and the Reynolds and Webster Springs is obtained from outcrops along Long Run down to where that stream reaches the base of the Webster Springs, 0.7 mile above where it joins Roaring Creek. The portion relating to the Glenray is obtained along a trench in the hillside of the divide between Long Run and Elklick Run, and close to Roaring Creek. The

portion relating to the Lillydale is obtained in part from the last-named locality and in part from the north end of Spruce Mountain a mile southwest of Onego.

Mauch Chunk Section along Long Run.

At the top, 160 feet of talus conceals the base of the Pottsville and possibly the top of the Mauch Chunk, the top of which is judged to be close to 4400 feet A. T.

	Feet.	Inches.
Bluestone Group (241½ feet)		
Largely concealed, apparently shaly	80	0
Shale, gray, clayey	30	0
Sandstone, white	10	0
Shale, gray, clayey	45	0
Coal, good	0	4
Shale, dark, clayey	35	0
Coal: 6 in. poor coal at top, 25 in. good coal at base	2	7
Shale, black, clayey	0	6
Sandstone, (**Princeton**, base at 4159′), coarse, gray, and gray shale	38	0
Hinton Group (880 feet)		
Coal, good, but irregular; many plant remains	0	9
Shale, gray, clayey	48	0
Coal, with 2-inch shaly parting through center; many plant remains	2	5
Shale, gray, clayey	8	0
Coal, bony	0	4½
Shale, dark-gray, clayey	10	0
Shale, black, clayey; many plant remains	60	0
Sandstone, brownish and gray	90	0
Coal, clean, roof good; many plant remains	1	7
Shale, dark, clayey	12	0
Coal	0	4
Shale, gray, clayey	23	0
Coal	0	7
Shale, gray above, black below, clayey	5	0
Sandstone, gray	20	0
Shale, mostly reddish, some gray; clayey (**Hackett**)	290	0
Sandstone, gray, conglomeratic, decomposing, in four ledges, top gray, others red, separated by shale; and shale, red	115	0
Sandstone, brownish-gray	20	0
Shale, red	25	0
Shale, gray	25	0
Sandstone, gray; numerous plant remains	3	0
Shale, red	85	0
Sandstone, reddish-brown	10	0
Shale, red	5	0
Sandstone, reddish-brown (**Hinton** of Stevenson)	20	0
Bluefield Group (600½ feet)		
Shale, red	35	0
Sandstone, reddish above, grayish below (**Graham**)	135	0

		Feet.	Inches.
Shale, reddish		20	0
Sandstone, reddish-brown, in ledge (**Bertha, Droop**)		35	0
Shale (**Ada**), gray, dark below, clayey, fossiliferous, especially in lower part; crinoid stems, Allorisma, Leda bellistriata (?) Stevens, Edmondia		78	0
Limestone (**Reynolds**), dense, dark-blue, fossiliferous in thin layer at top: crinoid stems	10 ft.		
(Mouth of landslide run at 2820 feet A. T.)			
Shale (**Reynolds**), dark, clayey, calcareous, fossiliferous: crinoid stems, Lingula sp.?, Productus ovatus Hall, Diaphragmus elegans Norwood and Pratten, Orthotetes kaskasiensis McChesney (very abundant), Spirifer pellaensis Weller, Composita sp.?, Allorisma clavata McChesney, Sulcatopinna missouriensis Swallow, Yoldia?, Myalina?	35 ft.		
Limestone (**Reynolds**), dark-blue, shaly, fossiliferous: Zaphrentis spinulosa Edwards and Haime, Crinoid stems, Fenestella tenax Ulrich, Productus ovatus Hall, Diaphragmus elegans Norwood and Pratten, Echinoconchus alternatus Norwood and Pratten, Orthotetes kaskaskiensis McChesney, Camarotoechia (?), Spirifer pellaensis Weller, Martinia sp., Composita subquadrata Hall, Allorisma clavata McChesney, Griffithides sp.	12 ft.	57	0
Shale (**Bickett**), red, sandy		106	0
Sandstone (**Webster Springs**), appears as a reddish-brown ledge of coarse sandstone, but is white within, not strongly cemented		30	0
Shale (top of **Glenray**), light-gray, with thin limestone, not well exposed	40 ft.		
Limestone, dark, dense, fourth limestone at outcrop, not especially fossiliferous	10 ft.		
Shale, not well exposed	12 ft.		
Shale, gray, calcareous, very fossiliferous: crinoid stems, Fenestella tenax Ulrich, Dielasma sp., Productus ovatus Hall, Diaphragmus elegans Norwood and Pratten, Pustula sp., Orthotetes keokuk Hall, Orthotetes kaskaskiensis McChesney, Camarotoechia (?), Spirifer pellaensis Weller, Composita subquadrata Hall	12 ft.		
Limestone, third limestone at outcrop, gray, shaly, fossiliferous: Fenestella sp., Productus ovatus Hall, Camarotoechia (?), Composita subquadrata Hall	3½ ft.		
Shale, gray, clayey, not especially fossiliferous	5 ft.		
Limestone, second limestone at outcrop, shaly, fossiliferous: Zaphrentis spinu-			

		Feet.	Inches.
losa Edwards and Haime, crinoid stems, Composita subquadrata Hall, Allorisma clavata McChesney....................	5 ft.		
Shale, gray, clayey........................	2 ft.		
Limestone (base of **Glenray**), lowest ledge at outcrop, dark, shaly, fossiliferous: crinoid stems, Diaphragmus elegans Norwood and Pratten, Orthotetes kaskaskiensis McChesney, Composita subquadrata Hall..........................	3 ft.	92	6
Shale (**Lillydale**), top reddish and grayish arenaceous shale at mouth of Long Run and not especially fossiliferous; near Onego a dark clayey calcareous shale, fossiliferous: Zaphrentis spinulosa Edwards and Haime, crinoid stems and calcareous pebbles, Productus ovatus Hall, Orthotetes kaskaskiensis McChesney, Allorisma clavata McChesney, very abundant..		12	0
Total...................................		1722	0

The various benches of Mauch Chunk sandstone and shale may be seen above the Greenbrier Limestone in the upper parts of Smith Mountain. To the north they flank the steep eastern margin of Roaring Plains. To the west they continue the steep southern face of Roaring Plains above Long Run. To the south of Long Run they occupy the upper half of Hoffman Ridge, all of Haystack Knob, and all but the topmost ledges of Green Knob. Farther west they occupy a small area of high ground just east of Job Knob and Gandy.

Southwest of Onego are extensions of Mauch Chunk high ground in Little Mountain, Spruce Mountain, and Timber Ridge. Farther southwest the Mauch Chunk of Timber Ridge unites with that of Spruce Mountain, and continues at the surface in a wide area southwest along the axis of Spruce Mountain to within a mile of Hunting Ground. In no other parts of the county are Mauch Chunk strata to be found.

In Mercer, Monroe, and Summers Counties both limestone and coal are reported in the Bluefield Group above the Bertha, or Droop, Sandstone, and there are many subdivisions inserted that do not seem to reach Pendleton County. In the Hinton Group of that region five horizons of coal are reported. In the corresponding part of the Long Run Section six horizons are noted, of which the principal one lies 78 feet below the Prince-

PLATE XLVII.—Webster Springs Sandstone making falls 0.6 mile from mouth of Long Run. (Photo. by Paul H. Price).

PLATE XLVIII.—Where Long Run crosses the Hinton (Avis) Limestone. (Photo. by John L. Tilton).

PLATE IL.—Top of Reynolds Limestone where crossed by Long Run about a mile northeast of Haystack Knob. (Photo. by John L. Tilton).

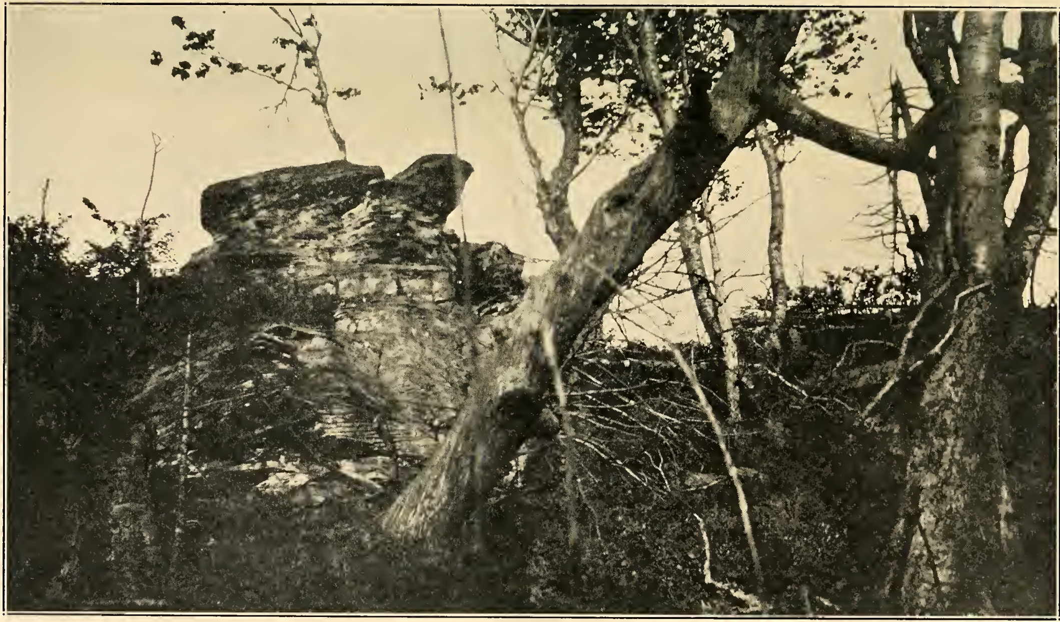

PLATE L.—Mauch Chunk Shale and Sandstone on the side of Green Knob. Green Knob is on the county line northwest of Mouth of Seneca. Its elevation is 4660 feet A. T. Its rocky summit is covered with ancient trees, logs and a tangle of brush. (Photo. by John L. Tilton).

ton Sandstone. Above the Princeton Sandstone there are in the Long Run Section two small seams of coal with considerable (35 feet) black shale between them. This horizon as a whole corresponds to that of the Pipestem Coal horizon of Mercer, Monroe, and Summers Counties. The horizon of the Hunt Coal lies higher in the Bluestone Group than is recorded in the Long Run Section.

In the Report on Mercer, Monroe, and Summers Counties D. B. Reger records a total thickness of 3450 feet of Mauch Chunk strata. The Mauch Chunk strata at Long Run, Pendleton County, have a total thickness of 1722 feet. In the Report on Mineral and Grant Counties to the north a total of 827 to 844 feet is assigned to the Mauch Chunk strata, which are there recognized as getting thinner northward[6].

Farther northwest in Monongalia County a total thickness of 415 feet of Mauch Chunk strata are reported[7], in which thinned-out portions of the lower members are recognized.

Paleontology.

In the preceding descriptions the record of fossils is included, especially in the table of strata. In this record there is a marked change from marine conditions below, through red non-fossiliferous sandstones and shale to gray conglomerate and sandstones above—in general from marine conditions below to shallow-water, shore, and fresh-water above. The list of Mauch Chunk fossils found is as follows:

Zaphrentis spinulosa
Crinoid stems
Fenestella tenax
Lingula
Productus ovatus
Echinoconchus alternatus
Diaphragmus elegans
Orthotetes kaskaskiensis
Orthotetes keokuk
Spirifer pellaensis
Comarotoechia (?)

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[6]West Virginia Geological Survey, Report on Mineral and Grant Counties, pages 133, 140, 144, and 194; 1924.

[7]West Virginia Geological Survey, Report on Monongalia County (pages 121 and 382), and Preston County, and personal observation.

Composita subquadrata
Martinia
Dielasma
Allorisma clavata
Leda bellistriata
Sulcatopinna missouriensis
Yoldia
Myalina
Edmondia.

Locations.

No. 63.—Lillydale. This collection was obtained one mile southwest of Onego in limestone conglomerate on the flank of Spruce Mountain:

Zaphrentis spinulosa
Crinoid stems
Orthotetes kaskaskiensis
Productus ovatus
Allorisma clavata.

No. 64.—Glenray. This series of collections was obtained along Roaring Creek, in the lobe of the hill between the mouth of Elklick Run and Long Run. The lowest limestone ledge (3 feet) contains:

Crinoid stems (and needles of FeS_2).
Diaphragmus elegans
Orthotetes kaskaskiensis
Composita subquadrata.

The second (5 feet) ledge contains:

Zaphrentis spinulosa
Crinoid stems
Composita subquadrata
Allorisma clavata.

The third (3½ feet) limestone contains:

Fenestella
Orthotetes kaskaskiensis
Productus ovatus
Diaphragmus elegans
Spirifer pellaensis,
Composita subquadrata
Camarotoechia (?)
Bellerophon
Orthoceras.

The 12-foot shale above the third limestone contains:

Crinoid stems
Fenestella tenax
Productus ovatus
Pustula
Diaphragmus elegans
Orthotetes kaskaskiensis
Orthotetes keokuk
Spirifer pellaensis
Dielasma
Camarotoechia.

No. 65.—Reynolds. The collection is from brownish sandy shale between two beds of limestone close to an old house on Long Run three-fourths mile from its mouth:

Crinoid stems
Lingula
Orthotetes kaskaskiensis
Productus ovatus
Spirifer pellaensis
Composita
Diaphragmus elegans
Allorisma clavata
Aviculopecten
Myalina
Sulcatopinna missouriensis
Yoldia
Bellerophon
Orthoceras.

No. 66.—Reynolds. This collection is from the upper of the two dark-blue Reynolds Limestone beds on Long Run, three-fourths mile from its mouth. It consists largely of small crinoid stems. There is also a minute gastropod too imperfect for identification, and a fragment of a brachiopod.

No. 67.—Reynolds. This collection is from a stratum of conglomeratic limestone in the bed of Long Run at the 2800-foot contour. Here the following were found:

Zaphrentis spinulosa
Crinoid stems
Fenestella tenax
Orthotetes kaskaskiensis
Productus ovatus
Echinoconchus alternatus
Spirifer pellaensis
Composita subquadrata
Martinia

Camarotoechia
Allorisma clavata
Griffithides.

No. 68.—Ada Shale. This collection is from the gray, clayey, Ada Shale near the bottom of the run on which a landslide is said to have occurred a few years ago. The mouth of this run is about half a mile below where the 2800-foot contour and the Reynolds Limestone are crossed by Long Run. Here were found:

Crinoid stems
Leda bellistriata
Edmondia
Allorisma clavata.

Plant fragments were found in the Hinton Group especially, but were not collected for identification.

The Mauch Chunk-Pottsville Contact.—At Spruce Knob beds of thin-bedded brownish and grayish Mauch Chunk sandstone extend to within 60 feet of the base of the Pottsville Conglomerate. In this interval there are at least ten feet of a brownish, clayey shale. Where examined there is no trace of coal. Apparently the remainder of the 60 feet consists of brownish weathered shaly sandstone.

Along Roaring Plains the contact between the Mauch Chunk Shales and the Pottsville is concealed by a heavy talus from the Pottsville Conglomerate above. Altogether it is noted that the Hinton Group with its gray sandstone, its shale, and its thin coal seams, the latter marking former swampy conditions, is followed by massive quartzitic conglomerate, a wide-spread shore formation. Such changes locally record another great disconformity. The change itself is no less remarkable than the changes which it indicates in the source from which such great masses of quartz were derived. Across the State it is noted that the Pottsville does not everywhere lie upon the same subdivisions of the Mauch Chunk, and that the Pottsville is more shaly farther south than it is in Pendleton County. This relation, together with absence of difference in dip between the two formations, marks a wide-spread disconformity.

THE PENNSYLVANIAN SYSTEM.

Pottsville Series, 160 feet.
Sharon Conglomerate and Shale.

THE POTTSVILLE SERIES.

(Map Symbol, Cpv).

West of North Fork Mountain.—Above the shaly top of the Mauch Chunk Series as found on the south flank of Roaring Plains a heavy talus resting on shale conceals the base of the Pottsville Conglomerate, and may conceal shale with a thin seam of coal ("Fire Creek"). 160 feet above this base of the talus is the top of the Pottsville Conglomerate, consisting of flattened white pebbles of quartz cemented by quartz into massive ledges ten or twelve feet thick. Along a portion of the Roaring Plains there are indications of the presence of shale between ledges of conglomerate. Depressions in the surface are swampy and, near the margin of the plains, covered with a thick growth of underbrush. There is here little chance to ascertain an exact section of the strata. The bottommost beds are undoubtedly beds of Sharon Conglomerate. Whether the topmost conglomerate is the Lower Connoquenessing (Lower Gilbert) or the Upper Connoquenessing can only be inferred from the thickness of the beds, for it can not be stated whether there are one or two intervening sets of shaly beds present.

The conglomerate caps a considerable area of Roaring Plains only a portion of which is within the bounds of Pendleton County. To the southwest a small area remains on the top of Green Knob, another in the high ground at the county line east from Job Knob, and another on the crest of the high ground half-way between Job Knob and Gandy.

Along the crest of Spruce Mountain it caps the highest ground directly west of Brushy Run School, and, within four

PLATE LI.—Looking along the ridge that divides the waters of Cheat River from those of the North Fork of the South Branch of the Potomac. Green Knob with an elevation of 4660 feet A. T. is seen in the center background. (Photo. by W. Va. Photo. Co.).

PLATE LII.—View of the Allegheny Front from the Timber Ridge road three miles south of Onego. (Photo. by West Virginia Photo Co., Thomas, W. Va.)

PLATE LIII.—Roaring Plains capped by the Pottsville Conglomerate. This level marking the Schooley Peneplain is approximately 4600 feet A. T. It also marks the Allegheny Front. (Photo. by Paul H. Price).

PLATE LIV.—Spruce Knob, the highest point in the State, 4860 feet A. T. The cap rock upon which is located a lookout tower is the Sharon Conglomerate of the Pottsville Series. Note the limbs of the trees pointing to the northeast. This area probably represents a monadnock above the Schooley Peneplain. (Photo. by Paul H. Price).

PLATE LV.—Haystack Knob, with its remnant of Pottsville Conglomerate, is a conspicuous feature from all directions. It is situated on the county line northwest of Mouth of Seneca. Along its side the old Indian trail passes from Seneca Rock to the northwest. In the background is the line of cliffs along Roaring Plains, capped by Pottsville Conglomerate. (Photo. by John L. Tilton).

PLATE LVI.—The second ledge of Pocono sandstone at the mouth of Roaring Creek. Close by is Onego. (Photo. by John L. Tilton).

and a half miles southwest, it caps three other stretches of high ground. After an interval of three miles it forms an almost unbroken crest to Spruce Knob, the highest mountain in the State, and about half a mile farther southwest it caps a small peak. In this last region barometric readings give a thickness of but 48 feet. At Spruce Knob it is about 150 feet thick. This massive ledge, protected from stream action along the axis of a great syncline, resists weathering and maintains these elevations. Elsewhere in this portion of the county it is eroded away. If it ever existed in parts of the county farther east no trace of it is left.

The Pottsville beds are the topmost beds of the geologic series in the county, excepting the terrace and flood-plain deposits of river gravels. No collection of plant fragments was made.

THE PLEISTOCENE AND RECENT SYSTEM.

(Map Symbol, Qal).

These deposits include the terrace and river valley clays, sands, and gravels, and the soils. Polished and striated subangular pebbles were not noticed; no special search was made for them. The subject of soils, so closely related to that of rocks, is presented in the chapter on Economic Geology.

Contact between the folded rocks and the terrace and river deposits.—The beds of stratified rock underneath the terrace and river deposits lie at all sorts of angles related to northeast-southwest folds, just as they were left by the last stages of folding to which they were subjected. During the time of folding and since that time the various underlying beds exposed at the surface have been subjected to erosion, until they have been worn down to the various valleys, lines of knobs, and mountainous ridges as we now see them. Some of the material worn from the former masses is still in beds of clay, sand, and gravel of terraces where left when the streams were flowing at the level of those terraces. Material at present in their intermittent progress to the sea may be seen along the valley bottoms. All of these various deposits

PLATE LVII.—Pottsville Conglomerate, top of Roaring Plains. (Photo. by Paul H. Price).

PLATE LVIII.—Pottsville Conglomerate with Spruce Knob in the immediate background. (Photo. by Paul H. Price).

PLATE LIX.—View east from top of Mauch Chunk, 4250 feet A. T., at head of Long Run, looking toward Roaring Plains. (Photo. by John L. Tilton).

PLATE LX.—Roaring Plains, as seen from one of the lower ledges on Long Run. (Photo. by John L. Tilton.

lie in beds that are essentially horizontal, and thus lie unconformably—with most pronounced and variable angular unconformity—upon the underlying stratified rocks already described.

Present river boulders and gravels.—In the streams the various partially rounded boulders lie commonly with their upper edges pointing down stream. Where the current is acting strongly upon these the dull grinding sound can be distinctly heard as the boulders move slightly one upon another. The fragments at the top are left where they happen to have been moved by the last high water that disturbed them, and the particles ground off join with the fine material washed in from the weathering mountainsides to be carried a little way, deposited for a time, then later carried farther on their journey to the sea.

The varying deposits along a river we may speak of as flood-plain deposits, but they are not of the character of alluvial flood-plain deposits which the fine material makes far down a river's course. In some favored nook the material is fine enough to form mud but generally the deposits are of sand and gravel, representing stages in the process of destruction of the material rather than stages in the building up of a flood-plain. The river terraces represent the former stages of such river action, a relation that may be seen along each of the rivers of the county. Such material is in unconsolidated, undisturbed beds and in that respect unlike the compact, resistant folded older rocks.

West of North Fork Mountain.—At Mouth of Seneca the terraces are well preserved. The flood-plain rises but seven feet above the river bed. The lowest terrace is here but eight to ten feet above the flood-plain, but it rises gradually to the west where at the distant border it is thirty-eight feet above the flood-plain, and is a third of a mile wide. In general this lowest terrace is thirty feet above the river. Under this terrace the truncated edges of nearly vertical Marcellus Shale covered by sand and rounded terrace gravel are visible near the mouth of Seneca Creek and along the hill to the south.

Forty-four feet above the low terrace is a second terrace.

Good evidence of its presence is seen in the hill south of Mouth of Seneca, for at this point the truncated Marcellus Shale rises above the level of the lowest terrace and is covered by the gravels of this second terrace. This terrace flat is also noticeable upon the northern side of Seneca Creek, where at the present time it is marked by a line of trees.

Sixty-one feet above this second terrace is a very conspicuous terrace well marked on both sides of Seneca Creek near its mouth. This is the highest terrace noted. It is thus 106 feet above the low terrace or 135 feet above the river and back away from the river rises to about 154 feet. Its surface consists of gravel and sand. Along the road south from Mouth of Seneca a cut reveals nearly vertical Marcellus Shale there truncated beneath the gravel of this high terrace.

The low terrace is very conspicuous along North Fork. On it are located Circleville and Riverton, the latter close to the flood-plain. On it also are most of the farm houses of the valley. This same terrace is conspicuous up Seneca Creek clear into the higher portion where lumbering is now in progress. On it Onego is located, many of the farm houses, and a considerable portion of the highway. In other streams, as Roaring Creek, Brushy Run, Dry Run, the same conditions exist. Along the lower courses of other but less important runs the terrace is clearly evident, but farther up these smaller and steeper runs the terrace disappears, merging with the flooded portions.

The second terrace is very fragmentary, including some of the low knolls left in the divides, and not traceable up the tributary ravines.

The high terrace is noticeable at many points, though rounded and sloping from long exposure to erosion. It is marked by the high shoulders of sand in the divides along the western side of the main valley, for North Fork in the main flows along the eastern margin of its valley, and is marked at scattered points along the lower courses of the main tributaries. Farther up the tributaries it loses its identity. Here torrents cut deep and the wash from the valley sides is very great.

East of North Fork Mountain.—East of North Fork

Mountain the same relations exist in flood-plain and river terraces as noted west of North Fork Mountain. High water erodes and deposits to a level of about seven feet along the rivers. Above this flood-plain there are three terraces visible at intervals of about 30, 50, and 60 feet, the surface of each terrace rising somewhat back from the river, and each with stratified clays, sands, and gravels lying unconformably upon the eroded edges of various beds, especially the shales (Marcellus-Hamilton-Genesee-Portage), for the principal valleys are shale valleys.

South Branch Valley.—From a mile southwest of Moyer Gap northeast to Mount Olive Church the road lies along the second terrace. Below it along the river is the low or first terrace, the site of well-built houses amid fields rich in wheat, corn, oats, and timothy. At Mount Olive the church and schoolhouse are built on an area of this second terrace about sixty feet above the river. Franklin is built on the second terrace, with the lowest terrace east stretching as a flat along the river. Two and a half miles straight north of Franklin there is a section of an alluvial cone of coarse material exposed by the roadside, the top of which is at the level of the second terrace, about 60 feet above the river. This gravel lies along the north side of a run that had been excavated previously and then this material deposited in the valley. A little to the east the beveled edge of Marcellus Shale is at the level of the gravel and the road lies along a terrace-like flat for two miles. In this latter region the base of the gravel is on truncated Marcellus and Oriskany at 30 feet above the low terrace, thus marking the level of the second terrace, but the gravel itself rises back away from the river toward the higher terrace.

From two miles south of Upper Tract to a mile and a half north of Upper Tract there is a broad view of both the lowest and the second terrace, a region recognized from times of earliest settlement as a rich agricultural region.

South Fork Valley.—From a mile south of Wilfong School northward to Sugar Grove there is, perhaps, the best development of terraces to be seen in the county. Here all three terraces are easily distinguished, including the one at about 135

PLATE LXI.—Consolidated terrace deposits of South Fork River, 0.5 mile south of Sugar Grove. (Photo. by Paul H. Price).

PLATE LXII.—River Terrace. This view shows the second terrace of the South Branch resting upon Marcellus Shale, south of Ruddle. The terrace is 30 feet above the first or low terrace. (Photo. by Paul H. Price).

feet above the flood-plain. Near the mouth of Stony Run the second terrace is 50 feet above the river, and at one place the lime from the Selinsgrove Limestone has cemented the gravel into a conglomerate.

In the long stretch of level ground between Brandywine and Oak Flat the second terrace is 25 feet above the first terrace. From Oak Flat to a mile northeast of Fort Seybert there are well-developed terraces on both sides of the river.

Traces of river gravels may be expected at still higher levels, for unquestionably rivers flowed at the level of the entrance of Trout Cave, and of that at the south end of Cave Mountain, both of which cave entrances are at about 250 feet above the present level of the river. Seven-tenths mile east of Schmucker School the sands and gravels are at a level of 1725 feet A. T., which is but forty feet above the drainage line into the large cave at Cave Mountain four and a half miles northwest.

Paleontology.

These clays and sands, and possibly the gravels, contain fragments of wood and of leaves washed in with the sediment and thus to that extent giving evidence of plants living at the time these deposits were made, and, combined with the deposits themselves, evidence of the character of the land. Fragments of other forms of life may occasionally be found, all related to life of the present or to that of the geologically not distant past. Some of this is Pleistocene—left when the various sheets of ice occupied regions not far to the north, during which time the local regions and those farther south still easily supported a flora and fauna, though on the high ground the snows of winter lingered longer than now; or left in the interglacial times, when the sheets of ice that had been not far north melted away. No attempt was made to search for fossils in these later beds, nor in the caves, one of which had, during the Civil War, served as a source of nitrates. Such deposits often contain remains of the animals that frequented them, sealed later by the drippings from the limestone walls.

PLATE LXIII.—A view from 0.6 mile southeast of Wilfong Church facing east, showing first, second, and third terraces of South Fork River. (Photo. by Paul H. Price).

PLATE LXIV.—One of the three entrances to Trout Cave in the face of a cliff of New Scotland Limestone three and a half miles southwest of Franklin, on the north side of the road and at a place 250 feet above the roadway. (Photo. by John L. Tilton).

The soils and other surface deposits contain evidence of the presence of man, for this was the Indians' hunting-ground, and often his battle-ground, until the white man came to till the valleys and to cut the timber. This passes the indefinite boundary between evidence of past life (fossils) and conditions and evidence of present life.

The Present.

The study of the history of topographic development leading to that of the present, to which the gravels are related as well as the carving of the mountain ridges and the development of peneplains, has been assigned to a chapter on physiography.

CHAPTER V.

THE GEOLOGIC STRUCTURE.

By John L. Tilton.

Terms Used.—The material of the various kinds of rock here described (not igneous) were laid down in layers (strata) in an essentially horizontal position. Where forces acting on the strata later bent them into folds resembling the letter U, the bend downward is called a syncline, the sides of which are called limbs of the syncline, which thus slope (dip) toward the bottom (axis) of the syncline. The direction of this axis is the direction of the strike, as N. 35° E., or S. 35° W. If the axis of the syncline bends downward it is said to pitch or plunge in that direction and to rise in the opposite direction. If the axis changes its direction sideways it is said to be warped.

When the forces acting on the strata bent the strata upward into an arch resembling an inverted U, the bend is called an anticline, the sides or limbs of which thus slope (dip) away from the top (axis) of the anticline. The direction of this axis is the direction of the strike. If the axis itself bends downward it is said to pitch or plunge in that direction and to rise in the opposite direction. Thus a region may be upwarped or downwarped; but there is also a horizontal change involved that affects the direction of the strike of successive folds. The limb of an anticline is also the limb of the next syncline, though there may be a flattening out (bench or terrace structure) along one of the limbs. A bend downward (or upward) between two horizontal stretches of strata is known as a monocline.

These synclines and anticlines may be erect (symmetri-

cal), or crowded over sideways, the limbs made to have different relations to the axial plane (unsymmetrical); or may be otherwise compressed.

A set of small anticlines and synclines in an area that is on the whole anticlinal is called a geanticline. So, too, a set of small anticlines and synclines in an area that is on the whole synclinal is called a geosyncline.

It happens, however, that in the formation of a set of mountain ranges the strata are accumulated in a great downward bend or trough that has been called a geosyncline. The material in all the Appalachian area, later crowded into the Appalachian folds, is spoken of as the Appalachian Geosyncline. Manifestly there is difficulty in applying the term geanticline or geosyncline to a set of folds that are grouped together, when there are many such groups of folds along the Appalachian Mountains, the material of all of which has been collected in a great Appalachian Geosyncline or trough. Consequently in the description that follows, the name geosyncline is avoided for an area with many smaller synclines and anticlines that on the whole make the area synclinal, and the name geanticline is avoided for a region where smaller synclines and anticlines are grouped in an area that is dominantly anticlinal. Instead of these terms the regions are spoken of as The Shenandoah Mountain Synclinal Area, The Elkhorn Mountain Anticlinal Area, etc. These groupings of smaller anticlines and synclines into greater anticlinal and synclinal areas are further traced northward into Maryland or Pennsylvania, emphasizing large units in the great Appalachian Mountain system.

The term anticlinorium has been offered for a grouping of anticlines and synclines into one great anticline, thus to that extent paralleling the term geanticline; but under its original use it further had the idea of a fan-like structure, a structure that does not here appear. Further, the term anticlinorium is associated with a conception of mountain building in a thin crust, an earlier conception that is not now held. Thus this term does not appear to be an acceptable term as applied to any of the great anticlinal regions of the State, nor to all of them combined.

PLATE LXV.—Entering Smoke Hole Settlement showing unsymmetrical arch, west limb slightly overturned, east limb in right background. (Photo. by Paul H. Price).

PLATE LXVI.—Small arch in Oriskany Sandstone, Smoke Hole Settlement. (Photo. by Paul H. Price).

The Structure in General.—Three great synclinal areas stretch from northeast to southwest across Pendleton County, and, between these, two great anticlinal areas. One of the great synclinal areas is on the east, the Shenandoah Mountain Synclinal area; another is on the west, the Stony River Synclinal area, along Roaring Plains and Spruce Mountain; and a third is near the center, the Middle Mountain ("Trough") Synclinal area. One of the great anticlinal areas includes the South Fork—Long Ridge—Thorn Mountain area. The other includes North Fork Mountain, the River Knobs, and the extensive valley between these ridges. There is still another area consisting of narrow synclines and anticlines stretching across the county from northeast to southwest in the region of Cave Mountain, Big Mountain, Timber Ridge, Castle Mountain, Ruleman and Simmons Mountains.

The two great anticlinal areas, and also on the whole the one in the western part of the county, though their axes rise and fall (pitch or plunge) and bend sideways somewhat along their courses, yet on the whole each is a great inverted arch, along the central part, or axis, of which resistant strata high in the air still defy the elements while the former extensions of these bends to the east and to the west have been erodd away. Thus these great mountainous masses are synclinal mountains. This is well brought out in the three diagrams shown on the Geologic Map (Map II) giving the structure across the county (A—A′, B—B′, and C—C′). The other of the three great synclinal areas, Middle Mountain ("Trough") Syncline, is wide at the north, and toward the south lies in the area of Colic, Lankey, and Pickle Mountains, from which to the southward the area is still more restricted. In general this is the area of the South Fork.

The two great synclinal areas, one in the eastern part and third great synclinal area, are areas of great crushing and folding, with numerous smaller interfingering anticlines, and somewhat of thrust-faulting.

Thus the structure of the county as a whole may be described as composed of two great synclinal areas, one on the east and one on the west, with a third great area between them that includes numerous anticlines and synclines, of which

the westernmost anticline (Wills Mountain Anticline) is in itself the most pronounced and extensive feature. These great areas have been traced from Pennsylvania southwestward across Maryland and West Virginia into Virginia, and the westernmost anticline (Horton Anticline) whose axis lies just west of Pendleton County, is now being traced farther southwest in West Virginia.

While mountains and large valleys are conspicuous topographic features by which to designate the general position of these anticlines and synclines, it must not be supposed that an arch upward (anticline) determines the location of a mountain, while an arch downward (syncline) determines the location of a valley. In a general way the reverse is true. Methods of deposition make it clear that all these strata were laid down in an essentially horizontal manner. In the movements that later threw them into folds the strata located where the bend was in general upward (anticlinal) were fractured variously along the folds while the strata located where the bend was in general downward (synclinal) were crowded together. Along the loosened anticlinal areas erosion proceeded rapidly, particularly where underlying less resistant strata, as shale, were exposed to stream action. Thus we have extensive valleys in areas of shale, while along these valleys lie ridges of resistant rock parallel to the direction of the general structure (N. 35°E.—S. 35° W.), but modified by cross-cutting along lines of minor fissuring and of tributary stream action. In anticlinal areas erosion cuts down the exposed edges along the anticlines and removes the less resistant strata there exposed. As erosion progresses the fissured anticlinal areas thus become the areas of the principal valleys. the areas of the compressed synclinal regions become the areas of synclinal mountains, and the lines of resistant strata along both synclines and anticlines become ranges and lines of knobs. Where resistant unfractured rocks are in the anticline an anticlinal mountain may result from erosion along the sides of the fold.

A further consideration of the results of erosion may be found in the Chapter on Physiography.

PLATE LXVII.—Scenery across the ridges. View fro m Mt. Horeb Church looking west to North Fork, Big, and Cave Mountains. (Photo. by Paul H. Price).

PLATE LXVIII.—Scenery across the ridges. View east from "Dolly Trail" with Peters Mountain in the foreground. (Photo. by Paul H. Price).

SHENANDOAH MOUNTAIN SYNCLINAL AREA.

Shenandoah Mountain Syncline.—A great anticlinal area (Whip Cove Anticline, Orleans, Pawpaw) has been traced from Pennsylvania across Maryland, then across Hampshire County to the southern part of Hardy County. Here the folds die out, and the syncline between the east and center divisions of the Whip Cove Anticline rapidly enlarges toward the south beneath the great synclinal Shenandoah Mountain, which forms the eastern border of Pendleton County. This new syncline is here given the name, Shenandoah Mountain Syncline. In the Franklin Folio (No. 32) of the United States Geological Survey the mountain is spoken of as "the synclinal Shenandoah Mountain."

THE ELKHORN MOUNTAIN—LONG RIDGE ANTICLINAL AREA.

Along the Hardy-Pendleton line from Sweedlin Valley to South Mill Creek, a distance of five miles, are numerous anticlines and synclines which, grouped together, make part of one extensive Elkhorn Mountain-Long Ridge Anticlinal Area, which has been traced from the central part of Hardy County across the southeastern part of Grant County for a distance thus far of 20 miles, and then for 24 miles farther across Pendleton County to where Long Ridge Anticline crosses into Virginia.

Sweedlin Hill Anticline.—The Sweedlin Hill Anticline enters Pendleton County 0.7 mile east of the Grant-Hardy corner and extends across Sweedlin Hill to Straight Run. Along the central portion a branch extends toward the southwest for two miles.

Deep Spring Syncline.—The Deep Spring Syncline, which has been traced for six miles in Hardy County to where it passes into Pendleton County 0.2 mile west of the Grant-Hardy corner, extends about three miles farther southwest into Pendleton County. To the west it has two branches

the farthest of which is just east of Shaver Run. These two branches also die out within three miles.

Elkhorn Mountain Anticline.—A little to the west of Deep Spring Syncline, or 1.6 miles from the Grant-Hardy corner, is the Elkhorn Mountain Anticline, where the main axis of the anticlinal area enters Pendleton County. This anticline has been traced from the west-central part of Hardy County southwest across the southeastern part of Grant County, a distance thus far of twenty miles. It is recognized as a distinct anticline for twelve miles farther, to 0.6 mile west of where the road from Franklin to Oak Flat crosses Long Ridge.

Long Ridge Anticline.—In the southern half of the distance that the Elkhorn Mountain Anticline lies in Pendleton County it is accompanied on the east by two other anticlines, with narrow synclinal areas between them. The eastern of these two anticlines, since it coincides with Long Ridge, is here named Long Ridge Anticline. This has been traced as a distinct anticline southwest through Thorn Mountain to where the anticline crosses the Virginia-West Virginia State line, a total distance that far of 24 miles.

Stone Mountain Anticline.—In the southern part of this area there are minor folds both to the east and to the west of this major anticline. On the east, one of these anticlines has its axis along Stone Mountain, and is hence called Stone Mountain Anticline, separated from Long Ridge Anticline by a narrow synclinal region along Whitethorn Creek.

Jack Mountain Anticline.—To the west of Long Ridge Anticline and separated from it by a synclinal area the strata rise, forming an axis along Jack Mountain Anticline, the effects of which are noticeable northeastward past Franklin to near Laurel Hill Church, a distance of 20 miles. A mile west of Jack Mountain another fold is noted in this general mass which is traceable through Pickle and Entry Mountains to the Virginia-West Virginia State line, a total distance of 15 miles.

THE MIDDLE MOUNTAIN ("TROUGH") SYNCLINAL AREA.

Middle Mountain ("Trough") Syncline.—The axis of

Middle Mountain ("Trough") Syncline lies along Middle Mountain, which lies between South Mill Creek and North Mill Creek, and crosses the Grant-Pendleton line at a point 4.5 miles northwest of the southeast corner of Grant County. This syncline has been traced for three miles along "The Trough" in Hampshire County, 19 miles across Hardy County, 10.5 miles across Grant County, and now 12.5 miles in Pendleton County, a total of 45 miles. In southern Hampshire and northern Hardy Counties, the erosion of shale along its axis has developed that remarkable topographic feature known as "The Trough". Toward Pendleton County the area of the syncline widens out, but for two miles above Ruddle the erosion there assumes a trough-like character. The continuation of this synclinal area southwest includes Colic Mountain and Lankey Mountain within its area. Farther southwest South Branch again flows in it for three miles.

Cave Mountain Anticline.—In Grant County Cave Mountain Anticline is traced for a distance of 16 miles. In Pendleton County it continues along Cave Mountain east of Smoke Hole Settlement for a distance of 10.5 miles.

Blue Rock Syncline.—West of Cave Mountain Anticline, at a distance of one and a fourth miles from Cave Mountain Anticline, the axis of Blue Rock Syncline crosses the Grant-Pendleton County line, half a mile west of a small thrust-fault. This syncline has been traced from a point 16 miles to the north in Grant County to the Grant-Pendleton County line and then for 25.5 miles southwest in Pendleton County. For four miles it lies along the remarkable canyon known as Smoke Hole, then between Big Mountain and Pretty Ridge, then west of Peters, Castle, and Ruleman Mountains, to where it dies out against the flank of North Fork Mountain, the east limb of Wills Mountain Anticline. East of Ruleman Mountain two minor anticlines appear with a syncline between them, one along Chestnut Woods, the other along Bobs and Simmons Mountains.

THE WILLS MOUNTAIN ANTICLINAL AREA.

Wills Mountain Anticline.—West of the Blue Rock Syncline the strata rise in a great arch, the surface also rising to

the crest of North Fork Mountain, which extends as a ridge of White Medina Sandstone stretching clear across the county from northeast to southwest. On the west side of the arch the continuation of this stratum appears again along River Knobs just east of North Fork, which ridge also extends as a straight wall of nearly vertical White Medina Sandstone clear across the county from northeast to southwest. Throughout this entire distance North Fork lies close along the west side of River Knobs. Between these two ridges of White Medina Sandstone flanked by adjacent strata the crest of the anticline has been eroded deep into underlying Ordovician strata.

The principal axis of this great anticline has been traced from Blair County, Pennsylvania, where it is known as the Wills-Dunning Mountain Anticline, across Maryland, Mineral County, Grant County, and now across Pendleton County into Virginia, a total distance within the State of 80 miles. The axis crosses the north Pendleton County line half a mile west of the crest of North Fork Mountain. To the west of this region and to the east of North Fork there are several small anticlines and synclines, one of which has been traced for 5.5 miles miles in Grant County under the name of Hopeville Anticline. It crosses the county line 0.2 mile east of the point where North Fork crosses the county line and extends but a mile into Pendleton County. Between this (Hopeville) anticline and Wills Mountain Anticline there are several crowded anticlines and synclines which farther southwest seem to merge with the Wills Mountain Anticline, the main axis of which here swings to the east a little, but in such a manner that the anticline is considered continuous. Farther southwest, near Judy Gap, the axis lies close to low-angle faults.

THE STONY RIVER—WELLERSBURG SYNCLINAL AREA.

Stony River Syncline.—From River Knobs west to the county line the strata form one immense syncline with its axis crowned most of the way by Pottsville Conglomerate, rising to an altitude of 4860 feet at Spruce Knob, and, with the exception of the gap at Seneca Creek, extending nearly across the county with but little change in elevation. It is to be re-

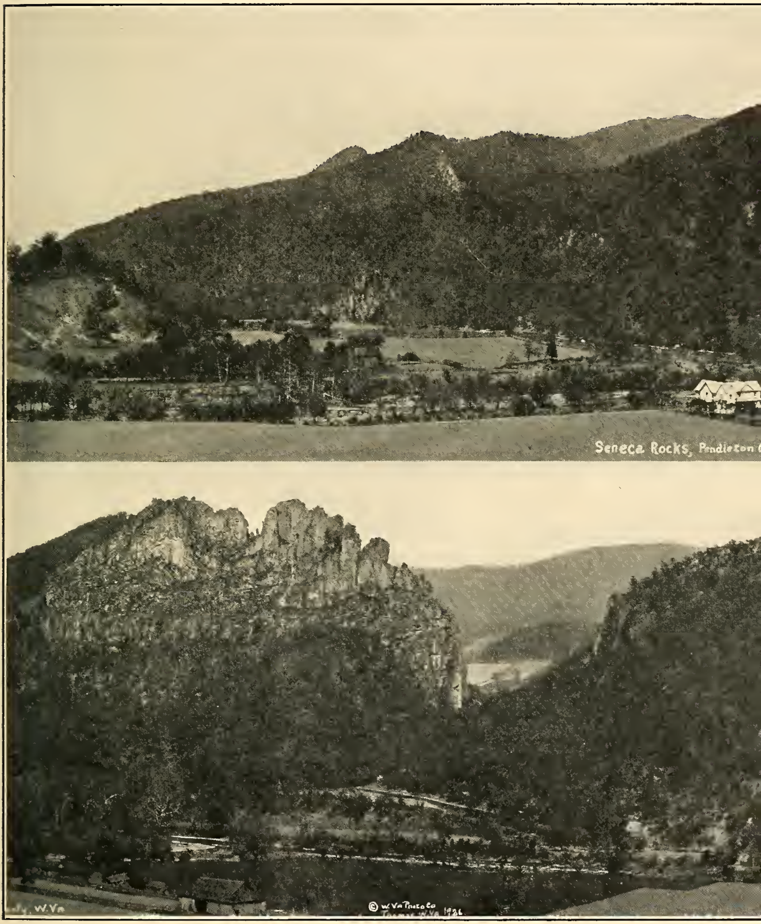

PLATE LXIX.—Panoramic view of Seneca Rock at Mouth of Seneca. Top view fits left-hand edge of lower view. (Photo. by West Virginia Photo Co., Thomas, W. Va.)

gretted that a structure that bears the highest mountain in the State, rising above such impressive surroundings, can not give its name to that structure. By priority in naming where the syncline was first located it can not be named Spruce Mountain Syncline but must be called Stony River Syncline. However, this syncline is a pronounced structural feature from Pennsylvania, where it is known as the Wellersburg Syncline, across Maryland, where it is variously called Georges Creek, North Potomac, and Stony River Syncline, across Mineral, Grant, parts of Tucker and Randolph, all of Pendleton, and on into Highland County, Virginia. Its axis bends considerably in the north, but measured along its general direction its length in each county is as follows: Mineral County 13 miles, Grant County 19½ miles, Tucker County, 9 miles, Randolph County, 3 miles, Pendleton County, 27 miles, a total of 71½ miles. In all this distance, it is considered a simple rather than a complex syncline. Along the eastern margin, just west of North Fork, the syncline is bordered by compressed folds, to the west of which are others that are broader, merging westward into the main syncline.

Horton Anticline.—From the axis of Stony River Syncline along Spruce Mountain and Roaring Plains in Pendleton County, the strata rise toward the anticline along the Allegheny Front. The axis of this anticline, which begins in Pendleton County west of Little Mountain and Hoffman Ridge, lies most of the way west of the county line; but it evidently passes through the western portion of Pendleton County farther south for just west of Grassy Mountain the dip changes from southeast to northeast. At a point a mile west of Grassy Mountain the dip is 43° northwest. As the axis lies but two miles east of Horton, Randolph County, Mr. David B. Reger suggests for it the name of Horton Anticline. Its extent to the south is not yet known.

THE CROSS-SECTIONS.

There are three sections drawn across the county: one (A—A′) near the northern part of the county through Hoffman Ridge and Sweedlin Hill; a second (B—B′) near the

center of the county through Franklin; the third (C—C′) near the southern part of the county through Snowy Mountain. These illustrate the relation of anticlines and synclines to each other as they appear across the county. There are also two smaller sections illustrating faults, one (D—D′) a section across a fault in the Smoke Hole area, the other (E—E′) across a fault in the Goshen School area.

Cross-Section A—A′.—Near the west end of the cross-section lies the northern end of the axis of the Horton Anticline. To the east toward Smith Mountain lies the Stony River Syncline. Here the surface is too low for the conglomerate that caps Roaring Plains to the north and Spruce Mountain to the south. East of this region the tsrata ris continuously toward the Wills Mountain Anticline whose axis lies west of North Fork Mountain. The rising strata on this west limb of the anticline bring to the surface the various beds of Devonian and Silurian strata in their order toward the Ordovician strata along the crest of the anticline, all dipping toward the northwest. Beyond this axis the dip is uniformly to the southeast to within a mile of South Branch, subject only to variations along minor folds. All through this area the strata come to the surface in an order the reverse of that found from west to east on the west limb of the Wills Mountain Anticline. Thus North Fork Mountain and the River Knobs mark the line of outcrop of the very resistant White Medina Sandstone.

The synclinal axis three-fourths mile west of South Branch is that of Blue Rock Syncline, 0.4 mile east of which lies the axis of Cave Mountain Anticline, which is here crossed at the north end of Big Mountain, just south of the entrance to the Smoke Hole area. Here sandstone capping the arch preserves an anticlinal mountain, all softer strata above having been eroded away down to this resistant rock.

A quarter of a mile east of South Branch lies the axis of another small syncline, with the axis of another small anticline a quarter of a mile still farther to the east, to neither of which has a name been assigned. Two miles farther east, or 4.4 miles east of South Branch, lies the broad synclinal area of Middle Mountain ("Trough") Syncline, here deserted by the

river, the folded structure to the west having afforded lines of more easy erosion in that direction. Along this shaly area of Marcellus, Hamilton, Genesee, and Portage strata lies the new highway between Petersburg and Franklin.

The east limb of this Middle Mountain Syncline is the west limb of the Elkhorn Mountain-Long Ridge Anticlinal area with its accompanying minor folds. The main axis here lies 1.7 miles west of South Fork Mountain, which the section crosses just south of Deep Spring Syncline, the syncline having faded out before reaching this point. Sweedlin Hill Anticline appears half a mile east of South Fork River. Half a mile north of the section South Fork turns to the right and flows along the axis of this anticline.

To the east of the Sweedlin Hill Anticline the strata dip regularly toward the axis of the great synclinal inverted arch above which rise progressively the various beds of Devonian strata to the Chemung sandstone that caps the mountain, a great synclinal mountain, with lines of knobs along its flank where resistant beds away from stream action come to the surface. The mountain is thus here a great pile of Chemung strata.

Cross-Section B—B′.—The axis of the Horton Anticline lies but 0.4 mile west of the county line. The axis of Stony River Syncline is crossed 1.8 miles east of the county line. Here Spruce Mountain is revealed in its true character, that of a great synclinal mountain whose crest is still maintained at an altitude of 4860 feet above tide by the remnants of Pottsville Conglomerate still left along the crest of the mountain. To the east the strata rise at increasing angles until at River Knobs, here half a mile east of North Fork, the White Medina Sandstone rises above the surface of the ground with somewhat of an overhang toward the west. Here, as all the way from the Virginia-West Virginia State line on the south to 1.5 miles north of the A—A′ cross-section, North Fork bends back and forth from the Helderberg Limestone on the east to the Oriskany Sandstone on the west, thus occupying what is essentially a shale valley, though a narrow one, since all the way the strata are nearly vertical in position.

From River Knobs east the strata form an immense un-

symmetrical anticline (Wills Mountain Anticline) cut deeply by stream action along the arch, with drainage through several narrow gaps opening to the west toward North Fork, the side of the steeper strata. On the east limb of this anticline the White Medina comes up to the surface along the crest of North Fork Mountain.

The syncline between North Fork Mountain and Peters Mountain is the Blue Rock Syncline. Then comes Peters Mountain Anticline, two miles east of North Fork Mountain. Here White Medina Sandstone is in the crest and a thrust-fault plane dipping southeast extends along the west side of the mountain. Brushy Mountain, a ridge 1¼ miles farther east, owes its prominence to Helderberg Limestone and Oriskany Sandstone.

Between Brushy and Colic Mountains the section crosses the axis of Middle Mountain ("Trough") Syncline. From Colic Mountain to a mile east of Franklin there are minor folds that are all involved in the Middle Mountain Synclinal area, along which flows South Branch, largely through areas of shale.

Long Ridge and Dickinson Mountain stand out distinctly along the Elkhorn Mountain Anticlinal area. To the west the strata as a whole dip toward the Middle Mountain Synclinal area; toward the east they dip southeast beneath Shenandoah Mountain.

Shenandoah Mountain, a great synclinal mountain along the eastern side of the county, is here capped by Pocono sandstone.

Cross-Section C—C′.—In the southern part of the county the Horton Anticline is close to the western border of the county, a part of what is recognized as "Allegheny Front". To the east the area of Stony River Syncline is somewhat flattened out, with a great extent of Catskill strata at the surface, which here reaches an altitude of 3965 feet above tide. East of Big Mountain the strata rise rapidly, along North Fork are vertical, and then to the east overhang somewhat to the west. This area is thus the western limb of the great Wills Mountain Anticline which here broadens out and includes Snowy Mountain as an uneroded mass of White Medina Sand-

stone between the outcrop of White Medina on the west that is a continuation of River Knobs, and North Fork Mountain on the east, a total distance of 3½ miles.

The Blue Rock Syncline having been pinched out farther north along the east side of North Fork Mountain (Wills Mountain Anticline), the first syncline now to the east followed by the anticline at Simmons Mountain may be considered either folds upon the eastern flank of Wills Mountain Anticline or folds along the western limb of Middle Mountain ("Trough") Syncline, along whose main axis lies the South Branch 1¼ miles east of Simmons Mountain.

At a distance of 1¾ miles east of South Branch lies Jack Mountain Anticline, with a smaller accompanying anticline along the west side, both capped by White Medina Sandstone. These, with Stone Mountain Anticline five miles farther east and Long Ridge Anticline between, are here considered a part of the great Elkhorn Mountain-Long Ridge Anticlinal area. In this section it is to be noted that the interior portion is flattening out.

To the east side of Stone Mountain the strata dip rapidly toward the region of South Fork, which is but 1⅓ miles away. In this region the strata form what is essentially a bench 1½ miles wide in the area of shale and shaly sandstone. Beyond this bench the strata dip steeply as the western limb of the great Shenandoah Mountain Syncline along the eastern margin of the county.

FAULTS.

Cross-Section D—D′.—This is a short cross-section but 4¼ miles long through Smoke Hole Settlement and Cave Mountain, from North Fork Mountain on the west to North Mill Creek on the east, along a line approximately half a mile south of the Hardy-Pendleton County line. Near the center of this region the line crosses a fault.

At the west end of the diagram the strata rise toward the axis of Wills Mountain Anticline, which lies but half a mile to the west. Toward the east and at a distance of 1.6 miles is the axis of the Blue Rock Syncline, followed in 0.2 mile by a steep-sided syncline and anticline in which Oriskany Sand-

PLATE LXX.--Looking east, White Medina along fault-line on Castle Mountain. (Photo. by Paul H. Price).

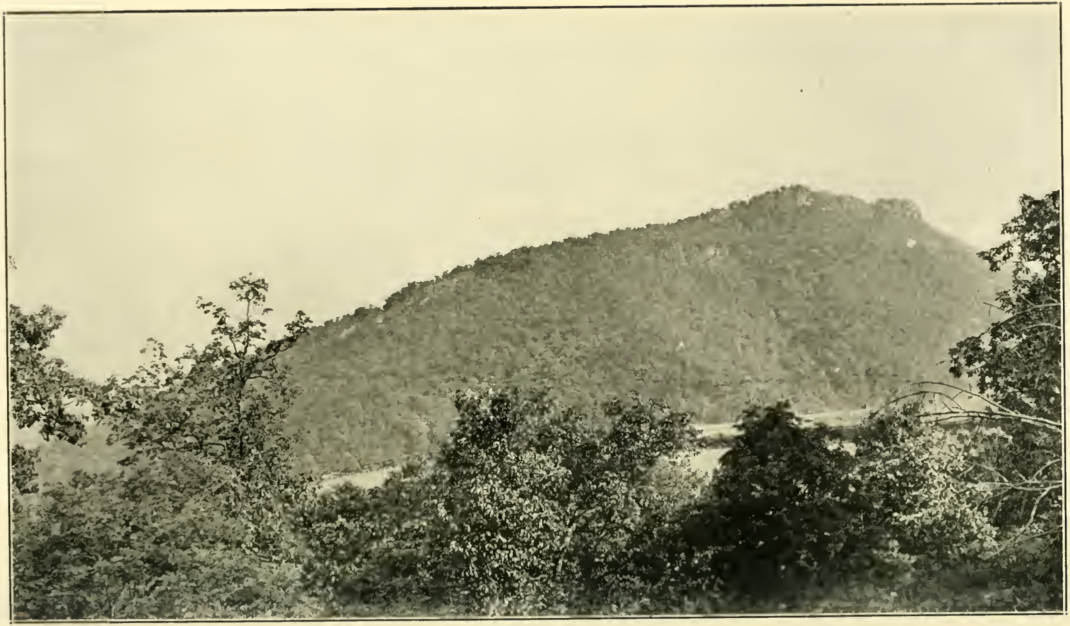

PLATE LXXI.—Looking east, White Medina along fault-line on Ruleman Mountain. (Photo. by Paul H. Price).

stone is at the surface. To the east only a part of the Helderberg appears to be present, followed in order toward the east, from Long Run along the bend of the river, by the Bossardville, Rondout, Bloomsburg, Niagara, and Clinton, all about vertical with slight overhang to the west, and all greatly mashed. In this crushed mass a part of the Helderberg seems to be faulted out. The mashing and the folding indicate a reversed fault, the upthrow being on the east side, with stratigraphic displacement of only a part of the Helderberg, perhaps 200 feet.

The river here lies a quarter of a mile east of the fault-plane with the axis of Cave Mountain Anticline close to the east bank. The surface then rises eastward toward the crest of Cave Mountain, which is capped by Oriskany Sandstone, but the strata dip steeply to the southeast toward Middle Mountain ("Trough") Syncline.

Cross-Section E—E'.—This is a short cross-section but six miles long expressing the relation of strata across a fault extending from 1.4 miles southwest of Upper Reeds Creek School to 2 miles southwest of Goshen School, a distance of 8.2 miles. The section extends across the area of Middle Mountain ("Trough") Syncline with its accompanying anticlines and synclines, the western one of which is the Blue Rock Syncline. Beyond this syncline the strata rise in the eastern limb of Wills Mountain Anticline. It is this rise of strata that appears for two miles in the western end of the section. The axis of the Blue Rock Syncline lies just west of the fault, and dies out 4½ miles to the southwest of Goshen School as it merges into the east limb of Wills Mountain Anticline. The fault lies along the west side of Castle Mountain and adjacent parts of Peters and Ruleman Mountains, which form a continuous anticline, that, toward the southwest, merges into the east limb of Wills Mountain Anticline. The next mile and a half to the east of Castle Mountain contains both a syncline and an anticline, the latter of which (Bobs Mountain) is capped by White Medina Sandstone, beyond which (east) the strata dip southeast to Middle Mountain ("Trough") Syncline. A mile from the east end of the diagram is the anticline of Pickle Mountain capped by White Medina.

Approaching the fault-plane from the northeast, one notes Bloomsburg Sandstone on the hillside just east of Upper Reeds Creek School, with Rondout just to the west, all dipping steeply northwest. To the east the Niagara is not well exposed, but the Clinton rises along the mountain and on the east side dips steeply southeast (25° 20′, strike N. 10° E.). Measured along the axis of the mountain from the road east of Upper Reeds Creek School, the Clinton alone appears at the surface for 1.3 miles to where the White Medina rises southwestward from beneath the Clinton and caps the crest of the mountain. This relation continues for half a mile farther southwest, the White Medina capping the narrow crest of the arch and dipping steeply beneath the Clinton on each flank. In another half mile southwest not only has erosion brought the Red Medina to view but the west limb of the White Medina has disappeared. Thus in Peters Mountain the fault begins to be evident approximately at the saddle 2.3 miles southwest from the east-west road near Upper Reeds Creek School. From this saddle on to the southern end of the fault, the White Medina curves over the crest of the Mountains (Peters—Castle—Ruleman), Red Medina appears along the west flank of the mountains, and the fault-plane outcrops somewhere in the talus near the base of the west flank of the mountains.

The fault is crossed by the road along Friends Run. At the west side of Castle Mountain the Red Medina appears by the roadside with steep dip (drag) to the northwest. Perhaps a hundred yards farther southwest up a small run is limestone that lies about 25 feet above the Hindella zone of the Bossardville, here dipping 28° southeast (strike N. 30° E.), the other lower formations appearing in order west up a small branch ravine close beside the old road to Circleville. In a direction at right angles to the strike this would bring the Red Medina, dipping northwest, to within 200 feet (from estimate and from map measurement) of Bossardville Limestone dipping southeast, which, at the angle of dip named, would give, perpendicularly to the Bossardville, an interval of 88 feet between the two strata observed. Evidently the Red Medina is thrust up over the Bossardville, the plane of slipping lying apparently 25 feet above the Hindella zone, a zone evident on the valley side.

This 88 feet includes badly brecciated Red Medina seen along the road, also other brecciated Red Medina and other strata (Bossardville?) concealed by the talus. The total stratigraphic throw is about 1900 feet for an overthrust from the base of the Red Medina to above the Hindella zone. The fault-plane itself is judged to parallel the limestone beds of the Bossardville, which here dip 28° southeast.

The fault is also crossed by the branch roads from Smith Creek. To the east of the road north from Goshen School, the crest of Castle Mountain is formed by White Medina Sandstone, with Red Medina Sandstone beneath it appearing well up on the mountainside and partly above the talus. On the road along the mountainside below the Red Medina is Niagara Limestone by the west side of the road. Below this level Niagara Limestone appears in Twin Run, and Keefer Sandstone appears on the farther (west) side of the valley where the dip is 15° southeast. Farther west along Twin Run the strata of the Clinton outcrop in the bed of the run, and then the White Medina comes to the surface dipping 15° southeast. The stratigraphic throw along the fault-plane is from the Red Medina to the Niagara, a vertical (stratigraphic) distance of about 1200 feet. The fault-plane itself is concealed by talus, which is very thick along the mountainside, so that it is not possible to note the effect of slipping or of crushing along the fault-plane, but the Niagara Limestone shows the effects of crushing and of infiltration of calcite. From the local conditions the fault is clearly of the overthrust type, with fault-plane dipping at low angle to the southeast.

At a distance of 0.6 mile southwest of Goshen School, Clinton Shale appears along the run, and limestone appears above it along the mountainside. On the high west slope of the mountain Red Medina outcrops and White Medina caps the mountain. At a distance of 1¾ miles southwest of Goshen School, the descending limb of White Medina appears in a nearly horizontal position. A little farther up the slope it dips 48° southwest. A short distance farther up and to the south the Red Medina forms a cliff with dip of 64° southeast (an overturn to be seen repeatedly along this unsymmetrical axis). Within a third of a mile southwest the White Medina

completes the arch, followed soon by the Clinton. All evidence of the fault disappears two miles southwest of Goshen School, near where the White Medina completes the arch and begins to pitch southwest beneath the Clinton.

Faulting in the Cave School Area.—In the Cave School area of the Wills Mountain Anticline, Dr. Prouty located pronounced overthrust faulting, particularly noticeable at Key where "low-angle faulting has caused some of the older beds toward the center of the anticline to be carried to the westward over the younger Ordovician shales". This distinct line of faulting with accompanying crushing and calcite infiltration he found extends "from about 200 feet southeast of Key to at least two miles to the northeast", while indications of the fault are traced for a distance of about five miles, from east of Harper Mill to east of Harman Knob. This is further illustrated and described in his treatment of the Ordovician strata in this Report. He further speaks of planes of crushing along the Red Medina beds that stand in a vertical position in River Knobs. In Noah Teter Hollow one mile south of Circleville this crushing may possibly be accompanied by faulting. So also to the northeast of Circleville, where the new graded road crosses North Fork Mountain "faulting may have caused repetition or loss of part of the thickness".

Close to River Knobs.—At the west side of the line of River Knobs the strata are approximately vertical clear across the county in a straight line northeast-southwest. Near Riverton and Circleville there is overhang of the White Medina to the northwest, with corresponding dip of strata to the southeast, but there was no evidence noted of displacement. Near the Grant-Pendleton County line and for a mile and a half southwest there is also an overhang to the northwest, the strata here also dipping to the southeast, the succession of strata so far as revealed indicating a mashing of the strata but no distinct faulting. The river itself and its area of flooding occupies a region of compressed anticlines and synclines along which Bossardville Limestone is at the surface. To the west of these compressed strata the Helderberg and Oriskany strata dip regularly to the northwest, the resistant Oriskany Sandstone capping the line of hills to the west.

OUT FROM FRANKLIN.

By John L. Tilton.

A description of trips north, south, east, and west from Franklin will further bring out the structure in the county and the character of the different strata.

North.

Travelling north from Franklin toward Petersburg one first passes around the north end of the Oriskany anticline along which Franklin is situated, winds to the west to cross Friends Run and then continues north along the west side of the hill of Oriskany Sandstone. Six-tenths mile north of Friends Run may be seen the black Marcellus Shale banked in upon the Oriskany on the right. As one passes over the hill and goes down to the river the Marcellus Shale is cut into again, and off to the east may be seen an arch of the Oriskany standing high above the river with Helderberg Limestone in the lower part of the arch. This is a continuation of the same anticline that has just been crossed. The Marcellus Shale has been completely eroded from the top of the arch leaving the resistant Oriskany Sandstone to defy the weather. Resistant though it is it has yielded to the river, which, following a course that was favorable at a former time, has continued to grind pebbles along the trench and to wash away loosened weathered material that fell into it until now the river flows through the ridge.

On turning to the west along the Marcellus Shale by the river and then to the northeast again one glides along the eastern flank of another Oriskany ridge rising steeply on the west, often with lines of cavities left where large fossils have been dissolved out. On the right by the river is the narrow flood-plain, then the broad first terrace about ten feet above the river, and then, near the upland, portions of the second terrace about twenty feet above the first.

As the river sweeps near the road it flows along the strike of the arch, at low water flowing over less resistant beds between the sloping beds of harder rock, running parallel to which the stream flows. In one place upon the left it passes a small patch of dark Marcellus Shale and then flows on to the edge of the Oriskany. Here, under the tremendous pressure that bowed up the strata a slight twisting has occurred, holding the Marcellus in the bend somewhat better protected from erosion than the beds to the east.

As one turns sharply to the left along another gorge cut like the first across an anticline of Oriskany Sandstone with Helderberg Limestone beneath, one comes upon the east side of this fold of Oriskany Sandstone dipping here to the east at Ruddle, and follows an almost straight course for three miles, the Oriskany as before rising upon the west, with eastern eroded portions lying in parallel lines in the river below. Then, on rounding the northern end of this fold as it slowly pitches beneath the lower terrace and beneath the river, one crosses the protected margin of Marcellus Shale and looks upon the four-mile stretch of beautiful first and second terrace land whose rich crops and fine farm homes proclaim one of the choicest agricultural regions in the county. The road lies along the second terrace, in a valley varying from three-fourths of a mile to a mile in width. Off to the right are the broad stretches of first terrace, and towards Reeds Creek stretches of second terrace reach conspicuously out to the east, proclaiming a time of deposition by Reeds Creek at a higher level than at present. Since the deposition of this terrace Reeds Creek has cut to a lower level, even below the first terrace, and established its gradient in accordance with that of the main stream, the "master stream" of the region. Similar relations may be noted where gullies from the upland reach the valley all along its course. At such places rather steep alluvial cones rising to higher levels are trenched by the present streams that flow a considerable volume of water in time of rain and shrink to nothing in dry weather, where what little spring water seeks the trench is soon lost in the porous gravel; but all such underground seepage keeps the second terrace well supplied with moisture. These alluvial cones rise above

the level of the second terrace due to the local excess of coarse material deposited at the edge of the steep slope, but the drainage along the main valley has paused near the level of the second terrace long enough for the Marcellus Shale to be cut down below the level of the terrace when the river was at or near such a point, and then as the river swung across to another part of the valley in cutting horizontally down to this level, deposits were left upon the protruding edges of Marcellus Shale. Later, as the streams cut to a lower level, it left these deposits as a terrace above its new flat. Much of the terrace has been washed away but enough remains to mark the level. So, too, on further cutting down by the river, the first terrace is left above the present flood-plain, but so low that its surface is endangered in time of flood, especially along the sags that have been developed in its surface by local wash.

The road northward toward Upper Tract extends diagonally across terraces on Marcellus Shale from one Oriskany arch to another. It comes to an arch at the bridge over Reeds Creek and, turning abruptly to the right, rounds the eastern slope of the lobe. Just beyond, it is on Marcellus Shale again, and then on Oriskany which lies to the west of the new bridge across South Branch.

Thus far from Franklin the road has followed the border line between Oriskany Sandstone and limestone (in places), and passed from one stretch to the next in the cross gorges cut by the river The gradient obtained for the road is almost perfect, crushed rock has been obtainable near at hand for the lower portions of the road filling, and shale obtainable near at hand for the top dressing. Complete drainage has been easy. All this was supplied in the geological conditions of the past, grasped by the road engineer, and used for an admirable shale road, a highway appreciated by all, the delight of the county.

From the new bridge one and a third miles north of Upper Tract the old road follows the Oriskany Sandstone past Kyle School toward Brushy Run. Instead of following that rugged course the new road here crosses the river and valley to pursue an almost straight course over shale to Petersburg. For two and a half miles the road lies on Marcellus Shale, but

its trend is away from Oriskany Sandstone and toward other shales that in position are above the Marcellus. First is the Hamilton Shale, somewhat like the Marcellus but even better for road construction. At Alt School and for half a mile beyond the shale outcropping by the road is Genesee Shale. Farther on to the county line the road is close along the Portage with its thin beds of sandstone included in the shale. These general conditions are continued to near Petersburg.

Down into Smoke Hole.

The entrance to Smoke Hole is a mile and a half north of Upper Tract.

Pendleton County presents two extremes in grandeur of scenery, one from the top of Shenandoah Mountain where one can look west across five large ranges and see Spruce Knob, the highest mountain in West Virginia, in the distance; or from the top of Spruce Knob or Roaring Plains at the west border of the county, where one can look across the intervening ridges and valleys to Shenandoah Mountain along the eastern side of the county, the boundary between Virginia and West Virginia. The opposite extreme from this grandeur of distant ranges is a view in Smoke Hole, where, from the depths of a chasm one looks up at great arches and in close view sees the strata bent and even doubled and twisted, exposed as a river has dissected the mountain in its age-long strife with rock.

Smoke Hole is charming and awe-inspiring, but under present conditions open only to the vigorous. Should one wish to see Smoke Hole and not walk, a saddle horse, aged enough to be steady and to scare at nothing, is one's best means of conveyance. A horse can pick his way around boulders that have tumbled into the road, and find his way out to the north, where the mail carrier comes in on horseback along a trail through the north end of the gorge. A buckboard, or a farm wagon, is the next best means of conveyance. In such a conveyance one can ford the river twice without inconvenience, and then find a strip of good dirt road toward Ketterman. One can find a way out up Dry Run

and then into Hardy County, or one can return part way to find a road up Dry Hollow and then south past Pretty Ridge School. An auto can reach the first ford, but here it must stop while one walks four miles to Ketterman near the county line and back, if one would see what of Smoke Hole lies within the county.

On turning west down the river from the iron bridge on the old road from Franklin to Petersburg, one passes immediately into a shady road full of muddy chuck-holes along the side of an Oriskany mountain. Around on the other side of this first fold a narrow strip of Marcellus appears in its proper sequence. Then comes another climb to the north along a steep and rough road. To the left Oriskany strata and then New Scotland rise steeply, the washed chert faces exposed studded thickly with the large shells that proclaim the beds to be the upturned beds of an ancient sea where the brachiopods were living when the strata were laid down in a horizontal position. (See Plate XXXIX). On the right the mountainside falls steeply to where far below the South Branch tumbles and roars along its rocky course. What would happen if one of the inhabitants should be coming the other way with a load of ties, presents an interesting problem, solved only by both parties as they look for a place where one can drive as near to the brink as possible while the other goes slowly along the upward slope until safely past.

Along the nose of the mountain the steeply dipping strata soon reveal the Bossardville in addition to the Helderberg and afford an explanation why the continuation of this mountain is called Cave Mountain. These nearly vertical limestones reach well up into that mountain. Across the river and far up the slope is the entrance to a cave where in former years it is said saltpeter was obtained for gunpowder. The cave entrance is now about 15 feet wide and 4 feet high and located at about the 2500-foot contour, a little east of the highest portion of the mountain. Inside the passageway is perhaps 20 feet wide and 12 to 15 feet high, and passable without much difficulty. A magnificent stalagmite covered with numerous fish-like surface decorations is now dark with mud or smoke, or both. Few stalactites appear within six hundred feet of

the entrance, but it is said that half a mile or so back in the cave they are to be found, and that the roof glitters with crystals of calcite. Mr. Ollie Kimball, who kindly acted as guide to the entrance from Kyle School, stated that he had been into the cave for a distance of two miles. Evidently a considerable portion of the axis of Cave Mountain is tunnelled with underground passages of old stream beds that slope downward to the north and afford drainage for the sink-holes along the mountain. Clearly it is the passageway of an old stream which dissolved out this old channel when the water was flowing at this level, that of one of the highest peneplains. Since that time the streams have cut down to the present level of the river, leaving this cave entrance high and dry.

Only a short distance farther west the Oriskany that caps Cave Mountain curves downward and then stands on edge, making a sheer cliff down to the river's brink. Just to the west the Oriskany rises again in another fold, leaving one to wonder whether in the narrow trough between walls of Oriskany any Marcellus is concealed beneath the river bed. Even such a question is answered with considerable certainty, for just around the bend is a little arch in the very bottom of the great trough. Thus we have here a triple arch: two great arches of mountains, one on each side, of Oriskany and all that underlies that bed; and here between, a small compressed anticline left by a turn in the river and so located that it is evident that where the river flowed along the arch it had cut down into the Oriskany itself. The continuation southwest along the strike of these folds leads to the region of compressed anticlines, synclines, and mashed strata that also appear along the road two and a half miles northwest of Ruddle.

For a mile along the river the road follows the strike of the Oriskany Sandstone not far above the level of the stream, then along a rocky bed eastward, then northward along the strike again for two miles. However, at the ford it is advisable to leave an auto without attempting to cross, for the ford has been found impassable for autos, and to take the trail along the west side of the river. The reason why the road does not continue that way is soon evident as one

approaches a huge mass of New Scotland Limestone, picks his way along the broken edges of a low cliff by the river, and then along high ground rising steeply above what is flooded at high water. The various pools of water between the ledge and the masses of loose rock afford numerous hiding places for trout which would be a constant source of temptation for a fisherman, but we want to see the rocks. The few houses are here located along the east side of the river. Farther on, the road crosses at a ford and lies along the west side to the mouth of Long Run, where it forks, one branch going up Long Run, the other along the river to Ketterman, beyond which there is but a bridle path along the west bluff by the river. It is in this region east of the mouth of Long Run that the lay of the rocks reveals the overthrust illustrated in cross-section D—D′ and described in the text on faults. The rocks that seem on edge are crowded over to the northwest and the mashed strata along the contact worn down by river action, and the great slopes on each side of the river are capped by beds of Oriskany Sandstone.

South.

South from Franklin the road lies for a mile and a half along the steep slope of an Oriskany ridge that rises steeply on the west and slopes down to the river below. Then the road emerges upon Marcellus Shale which it follows for two miles, to where it suddenly turns west through one of those gorges of which the South Branch and its tributaries furnish such numerous and impressive illustrations. The river has cut its way through a great fold of Oriskany and Helderberg strata that rise to a height of 500 feet to the north and even to a greater height to the south. It is here on the north in the upper portion of this limestone that the entrance to Trout Cave lies, 250 feet above the road. It is accessible only by climbing up the steep talus and then along the bluff, and gives little evidence of more than an occasional visit. It marks the same level above the stream below at which the entrance to the cave in Smoke Hole lies, mute testimony of former river action.

In the four miles to Mt. Olive Church and School, the road

continues along the Helderberg and Bossardville Limestones, with the Oriskany Sandstone of Pickle Mountain rising in a high arch upon the west, and across the river east the Oriskany of Sandy Ridge. Two miles farther on from Mt. Olive Church and School, the terraces along the river are prominent, then appear the steep sides of more resistant rocks to the county line. Part of the way the river and the road lie across Oriskany Sandstone and part of the way the road follows the Helderberg Limestone, the high White Medina ridge of Simmons Mountain appearing upon the west, and across the river, east, the White Medina in the great folds of Jack Mountain.

The names Cave School, Cave, and Dry Run emphasize a condition to be seen all through the region southwest of Franklin. Wherever the folds of limestone are above the drainage lines, crevices and caves lie along the mountainsides. Where the folds of limestone lie below the drainage the water in part disappears down the fissures, pursuing underground channels, only to emerge again and join the surface flow farther down the valley. Thus the streams are now doing what in former times they did at higher levels, where the drainage lines of caves still mark former watercourses.

East.

To go east from Franklin take the east fork within the city and cross the river a mile farther on. Here the road follows Marcellus Shale between mountains of Oriskany along Trout Run to where in a mile and a half it turns at right angles to get through a break in the ridge of Oriskany Sandstone and New Scotland Limestone where Trout Run has cut the way. In the next mile and a half the rising strata reveal Niagara, then Clinton, to the massive White Medina of Long Ridge Anticline at Hardscrabble Church and Troublesome Valley, between which places the Red Medina beneath is exposed in the arch. On crossing the divide at Hiveley Gap the Rondout and Bossardville appear, dipping to the east, then the thick Helderberg Limestone and Oriskany Sandstone, dipping beneath the Marcellus Shale, which is followed the remaining mile to Oak Flat.

To get farther east one should follow the shale valley of South Fork south to Brandywine, an air-line distance of three miles then turn southeast and begin the ascent along Hawes Run. For three and three-fourths miles the gradient is essentially that of the stream, but the Hamilton and Genesee Shales, not far from horizontal, are replaced by Portage, and within a mile the steeply folded Portage defies all attempts to ascertain its thickness. The base of the Chemung is reached in two and a half miles from Brandywine, beyond which the heavy beds of the Chemung appear and remain at the surface during the steep climb of the next two miles to the Hendricks Sandstone. The strata here dip uniformly, but the heavy beds of sandstone in increasing numbers present problems in engineering to determine a suitable route along the steep slopes to the divide, only a mile away in a straight line. Here, 25 miles from Harrisonburg, the grade goes down a tributary of the Shenandoah to the Valley of Virginia. To the north is the long ridge of Shenandoah Mountain with the Shenandoah National Forest upon its flanks there and in all directions along the mountain. To the south, less than a mile away, rises High Top 677 feet above the saddle, and capped by Purslane Sandstone. To the west, ridge upon ridge, are the broken lines of knobs of resistant Catskill and Chemung strata to the shale valley of South Fork, and then to the Oriskany and Medina ridges beyond, as far as the eye can reach.

A similar succession of strata and a similar grandeur in view can be obtained if one goes south to Sugar Grove and then turning east climbs to the Shenandoah divide.

West.

To go west from Franklin first go north for half a mile over the Oriskany Sandstone to where the road crosses Friends Run. Here turn west and for two miles farther follow the alternation of Marcellus Shale and Oriskany Sandstone to where at Lankey and Colic Mountains the deeper Bossardville comes to view. It is still a mile farther to Friends Run School, in which Helderberg and Oriskany strata are repeated.

PLATE LXXII.—Fire "Lookout" and cabin on Shenandoah Mountain east of Sugar Grove. (Photo by Paul H. Price).

PLATE LXXIII.—View southwest from tower on Shenandoah Mountain. (Photo. by Paul H. Price).

Then comes the Rondout. Farther on, in a mile beyond Friends Run School, the Niagara and Clinton strata appear, and then the White Medina on the east flank of Peters and Castle Mountains, there forming the crest, while beneath the arch the Red Medina appears along the road, next to which is a thrust-fault concealed in the talus. It is here, just west of Castle and Peters Mountains, that one may choose either the new road north to North Fork and Mouth of Seneca, or choose the old road west to Circleville and then to Hunting Ground and Spruce Mountain. The old road to Circleville is now rarely used.

The new road turns north just west of Peters Mountain and proceeds a little above the old Dolly trail, diagonally up North Fork Mountain, along Niagara and Clinton strata, with ever-increasing panoramic view westward until the crest is reached just north of Harmon Rocks. All the strata are dipping southeast as part of the east limb of the Wills Mountain Anticline. The steepest ascent of all is diagonally along the White Medina ledge at Harmon Rocks.

On rounding Harmon Rocks, where the White Medina is cut through to the Red Medina below, a new view suddenly appears, for here one looks down across the valley eroded along Wills Mountain Anticline to the line of River Knobs beyond. The valley of North Fork is shut out from view, but beyond appear Fore Knobs and Spruce Mountain.

Turning west down the mountain the Gray Medina comes to view and then almost immediately the Martinsburg Shale, which is followed along a winding road to Judy Gap. At Hopewell School is the axis of the anticline, but at a place just south of the region where the Chambersburg and Stones River Limestones outcrop along the valley. The limestone is penetrated by crevices and sink-holes along which drainage disappears beneath the surface, to reappear in springs farther down the valley. Such a spring is Judy Spring, where a small-sized river gushes out of the limestone and flows through Judy Gap to North Fork.

As the line of River Knobs is approached one comes again to the Gray and Red Medina, and then to the resistant White Medina in the western limb of the great arch, of which

PLATE LXXIV.—Road cut through White Medina Sandstone along the new State route from Franklin to Mouth of Seneca, on east side of North Fork Mountain. (Photo. by Paul H. Price).

North Fork Mountain is the east limb, and the valley between is the surface of what is left of the eroded arch. Judy Rocks are the high vertical masses of White Medina closing in upon the narrow gorge through which one must pass to the valley of North Fork beyond.

Along North Fork Valley the Clinton, Niagara, Helderberg, and Oriskany strata are nearly vertical and largely concealed by river deposits and terrace. Just west of the river turn north and follow the valley parallel to the jagged knife-like crests of River Knobs, past Riverton, to Mouth of Seneca, and here pause to see Seneca Rock, in the most picturesque region along the River Knobs.

At Mouth of Seneca turn west along Seneca Creek. For a mile the road skirts the northern slope of Timber Ridge, along Chemung and Catskill strata, then drops down into the valley of Seneca Creek. Onego is situated on Pocono sandstone at the mouth of Roaring Creek along which water flows partly underground and partly above ground, draining a large territory on the flanks of Smith Mountain, Hoffman Ridge, and the southern flank of Roaring Plains. It is through this region that the Stony River—Wellersburg Synclinal area extends, in which Spruce Mountain lies. The road past Onego crosses the axis of this syncline about a mile beyond that place, beyond which the rising Chemung and Pocono strata soon appear far up the mountainside. Where the road crosses the divide the strata are essentially horizontal. To the northeast may be seen Green Knob and Haystack Knob, each with its crown of horizontal ledges of Mauch Chunk and Pottsville. Here we are at the axis of the Horton Anticline.

If at Peters Mountain the old road west to Circleville is chosen, one here also mounts the successive beds of Niagara, Clinton, White and Red Medina until he stands upon the divide at North Fork Mountain. Looking to the east the Medina ridge of Castle Mountain looms up at a short distance, with other ridges and knolls beyond. To the west are the slopes of North Fork Mountain, and then the line of River Knobs, beyond which are the various ridges that flank the eastern slope of Spruce Mountain, with Spruce Knob, the highest mountain in the State, in the background. From the di-

vide the road is steep and winding, past the Gray Medina and then over Martinsburg Shale to where Gray Medina appears and then the White Medina of River Knobs, which stand as sentinels along the east side of North Fork, parts of the western limb of the great Wills Mountain Anticline.

At Circleville turn southwest and follow the river valley for a mile and a half. The strata, which here are vertical, are largely concealed by river gravels and terrace. At one and a half miles from Circleville a branch road turns west toward Hunting Ground and a steep climb begins along slopes around shoulders of Chemung, Catskill, and Pocono ledges standing high above the valleys until the divide at Hunting Ground Mountain is reached; then along the slope of limestone hills until Back Ridge School is reached, then a further climb until the summit of the main divide is reached. Here the road descends to the valley of Big Run, and then turns northwest to the west county line which is but a mile away.

From Hunting Ground Mountain to the west county line the strata form an immense syncline, in the Stony River—Wellersburg Synclinal area, the highest point of which is Spruce Knob. All the way the roads, though steep and rough, have been passable for autos, but at the present time there is no auto road to the top of the mountain. There is a trail, obscure in part, but walking is good, and a tramp of somewhat over four miles over ledges of Mauch Chunk and debris from Pottsville Conglomerate brings one to the bench mark, 4860 feet A. T., at the triangulation station and the fire lookout on Spruce Knob. While called a knob it is really an extensive flat of broken stone, clothed with huckleberry bushes. Here one looks east over ridges to Shenandoah Mountain, or west over the wide stretch of valleys and ridges of Randolph County.

CHAPTER VI.

AN IGNEOUS DIKE OF ALTERED AND EXTREMELY WEATHERED VOLCANIC BRECCIA.

By John L. Tilton.

The only occurrence of igneous rock[1] noted within the county is located 0.4 mile north of the Virginia-West Virginia State line, 0.8 mile west of Bull Pasture Mountain, in a rounded, somewhat isolated knoll with northeast-southwest trend, length perhaps 500 feet, width 200 feet. Patches of the rock are exposed along the hill, especially near its southern end where it stands out in large high rounded masses. In appearance the rock is dark-gray and fragmental, like an igneous conglomerate. It weathers readily, so that the rock itself is badly decomposed, and material from the rock is in the soil along the hill. To the west is Bossardville and Helderberg Limestone outcropping along the valley. To the east is Rondout and Niagara on the flank of a fold that branches from the Stone Mountain Anticline. The dike thus outcrops in a limestone area, with siliceous strata not far beneath and not far on each side.

In hand specimens the rock is hard, is dark-gray in color, with dark rounded fragments in a fine-grained, dark-grayish

[1]In the Staunton Folio (No. 14) N. H. Darton mentions two outcrops of diabase one of which mapped as 0.6 mile northeast of the State line is evidently the one here described. The other is located in Oriskany Sandstone (Monterey Sandstone) half a mile southwest of Laurel Hill School, which is presumably his location 2½ miles north of Doe Hill. It is the present writer's judgment that this last material, fragments of which were brought in for analysis, is Oriskany Sandstone there containing considerable iron but not enough to constitute an ore. The analyses may be seen under T. L. 20 and analyses of loose fragments under T. L. 21 and 22 in the present Report on Oriskany ore and sandstone.

matrix, with irregular somewhat yellowish planes of weathered material between the larger fragments. To the eye the fragments appear to be weathered pyroxene or weathered olivine; but the whole mass is so weathered as to give the rock the appearance of an agglomerate.

Under the microscope the rock sections reveal an abundance of weathered fragments accompanied by small pieces of olivine that are perfectly rounded, and other small crystals that are considered augite as the angle between the extinction planes is 42.7°. Around and in the decomposed masses are calcite, numerous crystals of perofskite, and grains of magnetite. Some of the magnetite is surrounded with hematite and accompanied by the yellowish-red wash of limonite. There are no distinct green borders of chlorite. The above, with the andesine, make up the bulk of the rock.

In places there are laths of feldspar, often with axes approximately parallel, the crystals distinct and clear but with wavy extinction as if subjected to pressure. These generally correspond to andesine though in the best test the angles between extinction planes lay between 59.2° and 61.5°, which corresponds to labradorite. Along with the laths of feldspar are lath-shaped crystals apparently of melilite, and flakes of mica, the latter seen partly on edge and occasionally on a basal plane, revealing negative character (biotite). Many of the smaller flakes are of biotite, with pink and yellow polarization colors, the space around containing an abundance of magnetite. In places there are spherical masses with radial structure of zeolites of analcite.

There are a few crystals of a clear hexagonal mineral with high index of refraction, often fractured, sometimes seen in basal section and sometimes in prismatic section, negative in character. These are crystals of corundum. Scattered through the mass are minute crystals, some positive and some negative, the first of which are considered rutile and the others apatite. There are also other very opaque needles lying across some of the transparent crystal fragments.

Discussion.—In considering the microscopic structure of the rock two conditions present themselves: that of the original igneous rock, and that of later decomposition products.

PLATE LXXV.—Igneous Dike, 0.4 mile north of Virginia State line, and 0.8 mile west of Bull Pasture Mountain. (Photo. by Paul H. Price).

PLATE LXXVI.—Knob made by Igneous Dike, 0.4 mile north of Virginia State line and 0.8 mile west of Bull Pasture Mountain. (Photo. by Paul H. Price).

What there is, if any, of the original forms of crystals is now obscure, for alteration products occur all through the rock, and the parts that most resemble crystal fragments are too altered to permit the application of optical tests. While they are dotted with granular magnetite the magnetite is not there so closely packed as it is in spots around these masses. They are irregularly fissured, and the fracture lines are occupied by opaque granules of magnetite and weathered material. Change to serpentine is not evident, the absence of which suggests that heat and pressure of metamorphism were absent, or in such a mass there would be evidence of serpentine. This is apparently the proper conclusion, rather than that later solution and change have obliterated all evidence of such an intermediate product.

Scattered all over the older partially decomposed masses and through the loosely arranged magnetite are clear colorless prisms whose principal axes lie in such a general but winding direction as to indicate flow structure. The appearance and optical tests mentioned refer these crystals to andesine and a few to labradorite.

The decomposition products are clearly evident in the scattered hematite, the yellowish-red wash of limonite to be seen all through the finer material, the banded arrangement around some of the fragments, the concentric structure of zeolites and the presence of calcite. Here, too, may belong some of the crystals of feldspar that are scattered through the decomposed material.

The biotite could well have been in such an igneous rock, but the freshness of the crystals indicates that it is a later product. Crystals of corundum, rutile, and apatite, especially the latter, may well have been in the original igneous rock. They are minerals that are resistant to chemical change.

While calcium is often a part of products of decomposition of minerals and the gas carbon dioxide may be occluded when crystallization in an igneous rock is taking place, the combination of which gives calcite, the calcite may have been formed in part by infiltration of calcium bicarbonate in solution, in the oxygen-bearing waters that have permeated the rock. To the permeation of such carbon dioxide and oxygen-

laden water is referred the excessive decomposition. Without proof that the fragments are weathered crystals of pyroxene or olivine, it is thought best to recognize the fragmental character and call the rock a volcanic breccia.

While it is difficult to obtain a satisfactory optical analysis of so decomposed a mass of minerals much of which is fine-grained, the following expresses results obtained:

	Per cent.
Feldspar	4.51
Corundum	4.79
Fine-grained ground mass, partly Olivine	32.78
Serecite and Kaolin	10.66
Magnetite	47.19
Apatite	Trace
Biotite	Trace
Rutile	Trace
Total	99.93

So peculiar is the rock that a small sample of it together with the best microscopic slide was sent to Professor Albert Johannsen of The University of Chicago for his judgment with reference to it. His reply is as follows:

"The rock is not a peridotite, neither is it a gabbro. It is composed of fragments of an andesite-like rock, cemented with similar material. Just from the one sample I should call it a breccia, such as is found on the slopes of volcanoes. It is coarser than a common tuff, although some may call it a tuff. I should say breccia is a better term. If all the rock is the same the name will be all right, andesitic-breccia. .... The small laths in the section are plagioclase—a basic andesine."

Chemical Analysis.

	1.	2.	3.
Fusing point of sample	2040°F.	.....	.....
Sulphur (S)	0.73	.....	0.38
Silica (SiO_2)	47.55	28.83	14.48
Ferric Iron (Fe_2O_3)	1.25	3.60	7.23
Ferrous Iron (FeO)	.....	5.13	3.13
Magnetite (Fe_3O_4)	13.25[2]	.....	.....
Alumina (Al_2O_3)	15.60	2.94	5.44
Manganese dioxide (MnO_2)	0.10	.....	.....
Manganese oxide (MnO)	.....	.....	0.27

[2]Mr. Kaplan states: "The iron is mostly in the form of magnetite (Fe_3O_4). There is some hematite as well. Approximately 2.5 per cent. of the alumina is in the form of corundum."

	1.	2.	3.
Lime (CaO)	9.15	11.24	.....
Calcium carbonate ($CaCO_3$)	.....	.....	18.21
Calcium phosphate ($Ca_3(PO_4)_2$)	Trace	.....	.....
Magnesia (MgO)	2.52	24.31	22.53
Potash (K_2O)	0.08	1.31	0.45
Soda (Na_2O)	0.80	0.75	0.53
Titanium oxide (TiO_2)	Trace	5.67	1.56
Phosphoric acid (P_2O_5)	0.83	0.77	0.30
Water of crystallization	5.60	3.96	8.46
Carbon dioxide	2.40	11.64	17.51
Totals	98.86	100.98	100.86

1. The altered and weathered volcanic breccia, Pendleton County, sample T. L. 39, Lab. No. 3023, analysis by B. B. Kaplan, Chemist of W. Va. Geological Survey.
2. Peridotite Dike in the Coal Measures of Southwestern Pennsylvania, J. F. Kemp and J. G. Ross, analysis by Miss M. W. Adams.
3. Mica Peridotite Dike at Dixonville, Pennsylvania, A. P. Honess and C. K. Graeber, analysis by T. W. Mason and H. Geist.

Of the various dikes reported in the Appalachian region the one at Gates[3], Pennsylvania, is the nearest. On comparing the analysis of this rock (No. 2 above) with that of the Pendleton County rock (No. 1 above) considerable difference is found. The Pendleton rock has much the more silica, iron, and alumina; the Gates rock much the more lime and magnesia. In Professor Kemp's recast of his analysis he has a higher percentage of biotite than is to be found in the Pendleton County rock. He considers serpentine a possible earlier mineral, but in neither his rock nor in the Pendleton County rock is serpentine found.

In the same report Professor Kemp gives a summary of the work of G. C. Matson on dike rocks found south of Glenwood, New York. He mentions: "olivine and biotite as the chief minerals present, with less abundant diopside, magnetite, ilmenite, perofskite, picotite, and apatite". That dike cuts rock "as high up as the Portage". In Pendleton County the dike now cuts rocks as high as the Bossardville-Helderberg groups. With reference to alteration products[4] in the dike

[3]J. F. Kemp and J. G. Ross: A Peridotite Dike in the Coal Measures of Southwestern Pennsylvania. Annals of the N. Y. Acad. Sci., Vol. XVII, Pt. II, No. 4, pp. 509-518, 1907; also Contributions from the Geological Department, Columbia Univ., Vol. XVII, No. 8.

[4]G. C. Matson, Peridotite Dikes near Ithaca, N. Y. Journal of Geology, Vol. 13, p. 267; 1905.

rocks found south of Glenwood, G. C. Matson finds that, "much of the olivine has been changed to serpentine with the formation magnetite, opal and a carbonate. The pyroxene is partly altered to calcite and serpentine. The ilmenite and titaniferous magnetite has been partly removed by solution, leaving a white cloudy substance, leucoxene. The perofskite has partly changed to calcite and rutile."

In October, 1926, a report appeared on a mica peridotite dike[5] at Dixonville, Pennsylvania, reported upon by Arthur P. Honess and Charles K. Graeber. The analysis of this rock (No. 3 above) reveals considerably less silica, alumina, and iron than is found in the dike rock from Pendleton County and considerably more magnesia and calcium carbonate. The description states that fresh olivine is not abundant, but occasional phenocrysts partially altered to serpentine throw some light on the changes within the dike following solidification. "The serpentinization in most cases has not been complete * * *" Small rutile crystals and perofskite, biotite, phlogopite, and ilmenite are recognized as primary. Plagioclase feldspars and other calcic minerals are distinctly mentioned as absent. Hydrothermal action is recognized. He notes that secondary rutile is present, also dolomite and calcite; but states that siderite is absent.

Thus the Pendleton County dike is very unlike the nearest dikes that have been reported upon. The chief differences center in the presence of andesine and magnetite in the Pendleton County dike.

[5]Arthur P. Honess and Charles K. Graeber, Petrography of the Mica Peridotite Dike at Dixonville, Penna. The Penna. State College Mining and Metallurgical Experiment Station Bulletin No. 2, Oct., 1926. This report also gives a table of analyses of dike rocks and a bibliography.

PART III.

Mineral Resources.

CHAPTER VII.

ECONOMIC GEOLOGY.

By John L. Tilton.

IRON ORES.

CLINTON SERIES.

Some time between 1880 and 1890 the Baltimore and Ohio Railroad Company employed Moore and Edwards to make such a survey of Pendleton County as would make clear the resources of Pendleton County in iron ore. Under the direction of these men pits and trenches were opened wherever it was thought desirable to reveal the character and thickness of the ore. None of the excavations exist at the present time. This work for the railroad company was continued in 1890 and 1891 by Dr. Edward Orton of Ohio and H. B. E. Nitze of North Carolina. The location of an excavation made at this time may still be seen on Iron Knob. The trench is slumped in, but on the ground around may be found fragments of the ore. A partial record of these excavations and the results of analyses have been placed before the public on pages 159-168 of Volume IV (1909) of the West Virginia Geological Survey by Dr. G. P. Grimsley. The report of N. H. Darton on the Franklin Folio also contains a brief discussion of the iron ore.

While the earlier trenches are now concealed there is a new source of evidence found in road construction. The part which is original in the present Report is based on exposures

of material along new roads and in the examination of ravines along North Fork which in the earlier days seemed too far removed from possible transportation to merit consideration. It may be said, however, that in the region that was not then investigated (along North Fork) there is no ore, the heavy red Clinton Sandstone not containing enough iron to be classed as an ore (see analysis below).

Figure 25, page 276, prepared by Paul H. Price, shows the areas of Pendleton County in which the Iron-Bearing Series (Clinton and Oriskany) of rocks occur at outcrop. On Map II, accompanying this Report in a separate Atlas, will be found these same outcrop lines in much greater detail.

The chief Clinton ore beds are along the flanks of Jack Mountain and Long Ridge, where it is especially available in the noses of anticlines, as near Dickinson Mountain School and Dahmer. The total linear distance along which outcrops of iron ore there occur is 66.5 miles. It occurs in the buff and green shales that are in the upper half of the Clinton Series. From the excavations formerly made to expose the ore the following measurements are recorded in Volume IV, West Virginia Geological Survey:

Bowman Prospect, Iron Knob.

The ore is horizontal, 19 to 24 inches thick, and at the prospect hole is under 4 feet of shale.

Wilfong Knob.

Upper layer, good ore	9 inches.
Middle layer, sandy ore	5 inches.
Bottom layer, slaty ore	14 inches.
Total	28 inches.

Wagner Knob.

Hanging-wall, green shale.	
Good ore	5 inches.
Dirt and clay	4 inches.
Sandy ore	18 inches.
Foot-wall, green shale.	

Half a mile south of Moyer Gap.

Hanging-wall, green shale.	
Good ore	6.5 to 9 inches.
Green shale	7.5 inches.
Good ore	3 to 4 inches.
Slaty ore	4 inches.
Green shale	9 inches.
Slaty and sandy ore	5 to 6 inches.
Foot-wall, green shale.	

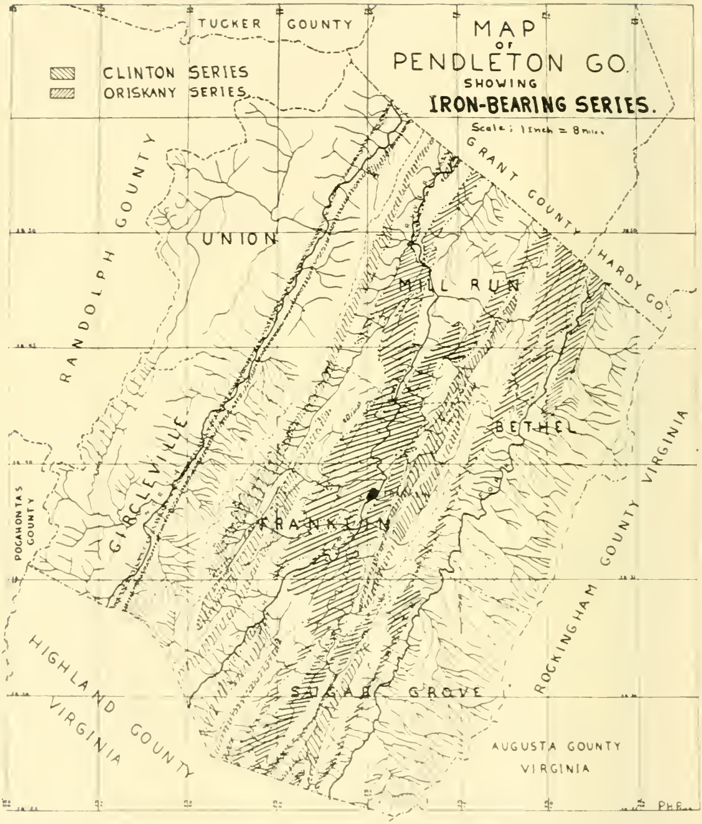

Figure 25.—Map of Pendleton County showing Iron-Bearing Series.

Estimate of Quantity of Clinton Iron Ore.

Between South Fork and South Branch Rivers the Clinton ore lies in bands along the Medina anticlines across the county from northeast to southwest. An attempt at an estimate of the quantity of ore in this region is presented on page 169 of Volume IV (1909) of the West Virginia Geological Survey, which reads as follows:

> "If the average thickness (of the ore) is taken as 24 inches, and it is assumed that the bed is continuous and workable to a depth, or better, to a width of 700 feet, there would be in this red hematite bed in South Fork Mountain in Pendleton County, about 6,750,000 cubic yards of ore. If one cubic yard of this ore weighs 3 tons, there would be 19,710,000 tons of ore, which would last three blast-furnaces with 500 tons each daily capacity over 40 years. If a value of one dollar per ton be placed on this ore it would represent a value of $19,710,000 for one of the undeveloped resources of this county, not including the value of other iron ores also present."

According to present figures the entire linear distance along which the Clinton Series extends on both sides of the anticlines where it comes to the surface between South Fork and South Branch Rivers is 66.5 miles. If the average thickness be assumed to be two feet and the width available 700 feet, as assumed in the Report mentioned, the ore available would be 18,206,222 cubic yards, or 54,618,666 tons of Clinton iron ore.

Diggings west from Bible Knob, Wilfong and Wagner Knobs, also Simmons Mountain, reveal a seam but five inches thick, and another too sandy to constitute an ore. The total linear distance along which outcrops occur in this region, including all between South Branch River and North Fork Mountain, is 59 miles, two-thirds of which is south of Franklin. A computation of the amount of ore available in a distance of 59 miles with an average width of 700 feet and an average thickness of 5 inches gives 3,365,185 cubic yards, or 10,095,555 tons.

Along North Fork ridge the Clinton Series outcrops for a distance of 23¾ miles within the limits of the county, but here it contains no ore, the nearest approach being a dense reddish sandstone an analysis of which is given below. Here

limestone occurs at or near the level in which ore is found in the central part of the county.

The analyses of Clinton iron ore of which samples were collected within the county, and of sandstone especially ferruginous, are as follows:

Analyses previously on record—Clinton Iron Ore.

	1.	2.	3.	4.	5.	6.
Metallic iron	57.09	52.03	51.21	50.07	51.80	53.70
Moisture	0.52	0.35	0.50	0.90	....	....
Loss on ignition	2.75	6.36	3.85	4.39	....	....
Silica	6.07	9.64	9.14	11.74	11.00	11.20
Iron oxide (ferric)	81.59	74.35	78.88	71.36	....	....
Calcium oxide	1.30	1.76	0.94	2.46	....	....
Manganese dioxide	0.04	0.02	0.04	0.04	0.050	0.40
Sulphur	0.01	0.06	0.02	0.03	....	....
Phosphorus	0.59	0.74	0.76	0.67	0.408	0.268
Titanium oxide	0.11	0.18	0.14	0.07	....	....

1. Iron Knob or Bowman Prospect, p. 164, Vol. IV, W. Va. Geol. Survey.
2. A. J. Pitzenberger Prospect, p. 162, Vol. IV, W. Va. Geol. Survey.
3. A. J. Pitzenberger Prospect, p. 162, Vol. IV, W. Va. Geol. Survey.
4. Bible Knob Prospect, p. 166, Vol. IV, W. Va. Geol. Survey.
5. Wagner Knob Pospect, p. 167, Vol. IV, W. Va. Geol. Survey.
6. Near Moyer Gap, p. 168, Vol. IV, W. Va. Geol. Survey.

Analyses by B. B. Kaplan from recent collections.

	7.	8.	9.	10.	11.
Metallic Iron (Fe)	46.74	27.00	37.41	12.30	50.51
Silica (SiO_2)	5.75	33.00	25.65	74.10	14.56
Ferric Iron (Fe_2O_3)	66.75	38.52	53.44	17.55	70.79
Alumina (Al_2O_3)	15.28	22.50	16.30	5.45	7.90
Lime (CaO)	0.12	....	....	....	....
Phosphoric Acid (P_2O_5)	1.17	0.75	1.26	....	0.16
Loss on ignition	10.25	4.75	3.07	3.00	6.36
Totals	99.32	99.52	99.72	100.40	99.77

7. L. T. 23, Lab. No. 2996. Fragment of Clinton iron ore from the west flank of Long Ridge at contour 3000, two miles due east of Franklin.
8. L. T. 24, Lab. No. 2997. Fragment of Clinton iron ore loose at roadside one-fourth mile south of Dahmer.
9. L. T. 25, Lab. No. 2998. Fragment of Clinton iron ore from old diggings at Iron Knob, 0.4 mile southwest of Dickinson Mountain School. This locality is the same as that from which No. 1 was obtained.
10. L. T. 5, Lab. 2965. Clinton Sandstone from gap at Seneca Rock. This illustrates the red ferruginous sandstones that are not ores.
11. L. T. 43, Lab. No. 3065. Ore from old diggings on Wilfong Knob, near Zigler.

It should be noted that the percentage of metallic iron varies from 27.00 per cent. to 57.09 per cent. of the total weight, that it does not contain sufficient sulphur to be inju-

rious or even troublesome, but that the phosphorus is far too much for Bessemer steel. The ore can, however, be smelted by the basic process and can thus be made to serve for blacksmithing purposes. The ores are high in silica, but this is subject to control in smelting.

ORISKANY SERIES.

Loose fragments of brown hematite associated with Oriskany Sandstone are found in several regions across the county. Fragments of it are seen near the Hampshire-Hardy County line east of Sweedlin Hill. Other fragments are still visible around old prospect holes in the William Boggs property in the saddle of a ridge between Long Ridge and Town Mountain, and on a knoll half a mile southwest of Laurel Hill School. This has the appearance of bog iron ore brought to light by erosion. In places it is thought to replace limestone below the Oriskany Sandstone. These ores were analyzed in the Survey laboratory with the following results (page 178, Volume IV, W. Va. Geological Survey). Other samples collected recently were also analyzed:

Analyses of Oriskany Ores.

	1.	2.	3.	4.	5.
Metallic Iron	34.42	32.27	33.87	37.33	45.20
Moisture	0.60	0.70	0.65	0.70	....
Loss on ignition	4.93	4.60	6.17	5.15	....
Silica	32.30	30.86	32.93	29.32	18.40
Iron oxide (ferric)	49.19	54.68	48.39	53.33	....
Calcium oxide	0.36	0.34	0.50	0.28	....
Manganese dioxide	0.065	0.06	None	0.035	0.06
Sulphur	0.05	0.09	0.09	0.12	....
Phosphorus	0.32	0.29	0.66	0.32	0.46
Titanium oxide	0.40	0.32	0.40	0.36	....

1. Elkins Tract.
2. W. Dickinson.
3. Wm. Boggs Tract, Little Mountain.
4. Wm. Boggs Tract, Long Ridge.
5. Brushy Mountain.

Analyses by B. B. Kaplan from recent collections.

	6.	7.	8.	9.
Metallic Iron (Fe)	....	....	27.96	24.19
Silica (SiO_2)	72.80	62.30	43.55	36.16
Ferric Iron (Fe_2O_3)	18.47	27.64	40.07	34.55
Alumina (Al_2O_3)	5.43	5.36	6.50	22.70
Lime (CaO)	0.22	0.30	....	....
Phosphoric Acid (P_2O_5)	....	....	0.72	0.63
Loss on ignition	3.05	4.39	8.90	5.45
Totals	99.97	99.99	99.74	99.49

6. L. T. 20, Lab. 2983. Oriskany ferriferous sandstone from end of hill one-half mile southwest of Laurel Hill School. This is the plaee mentioned in the Chapter on igneous rock where igneous rock had been reported as present.
7. L. T. 21, Lab. No. 2994. Loose fragment of ferriferous Oriskany Sandstone from end of hill one-half mile southwest of Laurel Hill School.
8. L. T. 26, Lab. 2997. Loose fragment of Oriskany ore from valley one-half mile east of Spring Mountain.
9. L. T. 27, Lab. No. 3000. Oriskany ore from old diggings two miles east of Franklin, 0.6 mile north; also one-half mile east of Town Mountain, in saddle along the erest.

The base of the Oriskany where the ore occurs has a very irregular course from South Fork River to North Fork Mountain, and evidence that iron is sufficiently abundant to constitute an ore is so scattered that it does not seem advisable to attempt an estimate of the amount present. East of South Branch River, including the area east of Sweedlin Hill, the main direction of outcrop is northeast-southwest from the Hardy County line to Laurel Hill.

It should be noted that the content of metallic iron varies from 24.19 per cent. to 45.20 per cent. of the weight, thus being a lower grade ore than the Clinton ore. In phosphorus the two ores are not very unlike, both containing too much phosphorus for Bessemer ore. In the presence of less sulphur the Clinton ores are somewhat better than the Oriskany ores.

Manganese.

The ore obtained from Oriskany on the west shoulder of Bible Knob contains such a percentage of manganese dioxide that it is a low-grade manganese ore. None of the other analyses give more than 0.4 per cent.

Analysis of Ore from Bible Knob.

	10. Per cent.
Silica (SiO_2)	38.08
Ferric Iron (Fe_2O_3)	8.84
Alumina (Al_2O_3)	8.48
Manganous Oxide (MnO_2)	31.95
Magnesia (MgO)	0.50
Phosphoric Acid (P_2O_5)	0.05
Loss on ignition	10.92
Total	99.82

10. L. T. 42, Lab. No. 3064. Ore from old diggings on the west shoulder of Bible Knob, three miles west of Franklin.

Mr. B. B. Kaplan, who made the analysis, further states: "This ore contains 20.19 per cent. of metallic manganese . . . Its maximum value, f. o. b., would be about six dollars per ton."

WITH REFERENCE TO COAL, OIL, AND GAS.

Coal.—The presence of coal in the very next county west, and also to the north and to the southwest within the State, naturally raises the question as to whether coal may not also be found within the borders of the county.

In the regions named the beds of coal are all either in the Mauch Chunk or in strata above that horizon (Pottsville, Allegheny, Conemaugh, Monongahela). Consulting the structure sections and the geologic map of the county accompanying this Report it will be noted that the Mauch Chunk and Pottsville only of the coal-bearing strata of the State extend into Pendleton County. It will be noted that the lower beds of the Pottsville Conglomerate cap Roaring Plains and lie along the crest of Spruce Mountain, the Mauch Chunk lying next beneath. East of that region, while the various strata rise and fall along the anticlines and synclines, only lower beds appear at the surface. How far the coal beds used to extend is not now evident, though to the north they are still preserved in the very synclines that cross Pendleton County. The eastern extension of the coal beds has been completely removed in these regions of Pendleton County, and the erosion continued until other strata far below the horizon of coal seams are now exposed at the surface. Some of these older beds

PLATE LXXVII.—Where the lowermost coal outcrops about half way up landslide run. (Photo. by John L. Tilton).

contain impressions of plants and some even have thin dark soil-like strata. Reference has already been made to evidence of plants found in the Catskill, Chemung, Pocono, and Marcellus. In places the presence of black carbonaceous material is so abundant as to excite hope that coal is present, but in none of these beds has anything more been found than evidence of the plant life of those ancient times. There are no beds of coal in those strata.

Referring now to the Mauch Chunk and to the Pottsville along Roaring Plains, the section made along Long Run and then up a steep run down which a landslide is said to have occurred a few years ago contains the following information:

Mauch Chunk Strata with Coal.

	Feet.	Inches.
Bluestone Group (241½ feet).		
Largely concealed, apparently shaly	80	0
Shale, gray, clayey	30	0
Sandstone, white	10	0
Shale, gray, clayey	45	0
8. **Coal,** good	0	4
Shale, dark, clayey	35	0
7. **Coal:** 6 in. poor coal at top, 25 in. good coal at base	2	7
Shale. black, clayey	0	6
Sandstone, Princeton, base at 4159 feet A. T., coarse, gray, and gray shale	38	0
Hinton Group (880 feet).		
6. **Coal,** good, but irregular; many plant remains	0	9
Shale, gray, clayey	48	0
5. **Coal,** with 2-inch shaly parting through the center; many plant remains	2	5
Shale, gray, clayey	8	0
4. **Coal,** bony	0	4½
Shale, dark-gray, clayey	10	0
Shale, black, clayey; many plant remains	60	0
Sandstone, brownish and gray	90	0
3. **Coal,** clean, roof good; many plant remains	1	7
Shale, dark, clayey	12	0
2. **Coal**	0	4
Shale, gray, clayey	23	0
1. **Coal**	0	7
Shale, gray above, black below, clayey	5	0
Sandstone, gray	20	0
Shale, mostly reddish, some gray; clayey (Hackett)	290	0

Here there are eight seams of coal within a vertical distance of 333 feet, the lowest one at 498 feet below the top

of the Mauch Chunk, or 658 feet below the nearest top of Roaring Plains. Of the eight seams six are in the Hinton Group and two in the Bluestone Group. Of these the third (1 ft. 7 in. thick) is the best, with its pure coal and its good roof. The fifth has a 2-inch shaly parting and a poor roof. The seventh has 25 inches of good coal at the base, but it lacks a good roof. This seam is at the horizon of the Pipestem Coal farther south. The same relation exists along the flanks of Spruce Mountain beneath the Pottsville.

While all these seams are too thin to be attractive they can be mined and the coal carted away or lowered to the floor of Long Run by buckets on an endless cable. The smallness of the market, the difficulty of transportation and the thinness of the seams, do not present a suitable commercial proposition.

Whether there is coal of value in the base of the Pottsville concealed by the talus it is impossible at present to tell. In distant places a thin seam of coal is reported at this horizon.

Of the two samples of coal analyzed, No. 1 is from the lowest seam, No. 2 is from next to the highest seam. Other tests were not made for lack of sufficient material:

Samples of Coal, Analyses by B. B. Kaplan.

	1.	2.
Moisture, sample as received	4.23	2.80
Volatile Matter	20.42	17.40
Fixed Carbon	66.35	60.70
Ash	9.00	19.10
Totals	100.00	100.00
Sulphur	0.62	0.32

1. T. L. 19, Lab. No. 2982. Coal from the lowest seam. The coal does not coke.
2. T. L. 18, Lab. No. 2981. Coal from next to the highest seam, the seventh.

These analyses give data for the determination of the fixed carbon ratio at a point farther east than has before been available in the central part of the State:

$$\text{No. 1.} \quad \frac{66.35}{(66.35 + 20.42)} = 76.4 \text{ per cent.}$$

$$\text{No. 2.} \quad \frac{60.70}{(60.70 + 17.40)} = 77.7 \text{ per cent.}$$

The average of the above is 77 per cent., a percentage to which reference will be made in the consideration of oil and gas prospects.

Oil and Gas.—In a region of such folded, fractured, and in places even faulted strata as found in Pendleton County there is little chance for oil and gas to accumulate in the various porous beds. Further, in determination of the carbon ratios of coals, which is the relation between the fixed carbon and the sum of the fixed carbon and volatile material,

$$\frac{\text{F. C.}}{\text{F. C.} + \text{V. M.}},$$

it is found that oil and gas are not in paying quantities where strata have been disturbed sufficiently to give a carbon ratio of more than 65 per cent. Isocarb lines for the various percentages found have been plotted on the map of West Virginia by Mr. D. B. Reger[1].

The lines for 65 per cent. and 70 per cent. pass in a general north and south direction west of Pendleton County. The presence of coal in Maryland and northern West Virginia and also the presence of it in the southern part of the State, has made it possible to see where the 75 per cent. and 80 per cent. lines lie. They are so directed in the regions where known that if continued they would lie across Pendleton County. From the two samples of coal collected on the side of Roaring Plains it is seen that the 77 per cent. line passes through that region.

The evidence at hand, then, is against the possibility of finding commercial quantities of either oil or gas in Pendleton County.

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[1]D. B. Reger, Carbon Ratios of Coals in West Virginia Oil Fields. Trans. Am. Institute Mining and Metallurgical Engineers; Petroleum and Gas, Vol. 65, p. 522; 1921.

LIMESTONE.

Great beds of limestone are to be found in the Bossardville, Helderberg, and Greenbrier Formations, smaller beds in the Clinton, Niagara, Rondout, Chemung, and Mauch Chunk.

West of North Fork.—North Fork flows along the west limb of Wills Mountain Anticline where the Bossardville and Helderberg Limestones dip beneath the surface. These masses of limestone are thus frequently in evidence, as at the mouth of Dry Run, Circleville, and below the mouth of Shafter Run. A few rods to the east in the gaps Niagara and Clinton Limestone beds dip steeply beneath the river. In the Chemung along the west side of the valley the thin layer of limestone is not of importance in this connection. Farther west the Greenbrier Limestone lies along the mountainsides from the Grant-Pendleton County line on the southern end of Smith Mountain, thence northward along Roaring Creek to half a mile above Roaring School, and westward along Hoffman Ridge to the Randolph-Pendleton County line. South of Mouth of Seneca it forms a long band along the east flank of Timber Ridge and Spruce Mountain to Hunting Ground. West of Mouth of Seneca and south of Seneca Creek it borders both Timber Ridge and Spruce Mountain and extends along Brushy Run between them to a point three miles above Brushy Run School. Along the west side of Spruce Mountain it forms a band extending to Hunting Ground where, south of Spruce Mountain, it unites with the area east of Spruce Mountain. Beneath the surface it underlies Smith Mountain, Hoffman Ridge, and all of the county to the north and west of these areas, and to the south it underlies Spruce Mountain.

In the Mauch Chunk the Reynolds Limestone and the Hinton (Avis) Limestone, the former of which is the more important, lie along the mountainsides in the area of Mauch Chunk, above the areas of Greenbrier Limestone already noted.

Thus the valley of North Fork is well supplied with limestone close to the river, and back in the highlands there are

these other beds of limestone. In quality some are too high in silica (see table of analyses) to be thoroughly satisfactory for use. All serve to neutralize the acidity of soil so situated that lime-laden water percolates through it. Those showing the least silica (sand) should be the ones selected to crush and scatter over the fields, or to use for lime or cement.

Wills Mountain Anticline.—Along the axis of this anticline from a mile east of Harper Gap to near Hopewell School erosion has laid bare the deep Ordovician Limestone along the axis of the anticline. These massive beds already are an abundant local source of supply for the various uses of lime. For analysis see No. 35.

East of North Fork Mountain.—East of North Fork Mountain the limestone strata follow in outcrop the lines of strata as already described. In this area there is no Greenbrier, no Mauch Chunk, no Ordovician Limestone, and the bed of limestone in the Chemung is not of importance in this connection. That limits the area in which limestone is common to the area between North Fork Mountain and South Fork River, in which area the various limestones are exposed along the numerous folds. Along the area of Medina Sandstones exposed in the axes of the greater anticlines, as Long Ridge, Bobs-Simmons, Ruleman-Castle-Peters Mountains are the stretches of Clinton and Niagara Limestones in thin belts dipping steeply on the flanks of the anticlines[2]. If we note also the position of the other great bed of sandstone, the Oriskany, seen abundantly represented along all of the other mountains in a northeast-southwest direction through the center of the county, we have the areas along which the great masses of Helderberg Limestone are exposed. This whole central region is thus abundantly supplied with limestone from the purest to that which contains chert, or is thin-bedded alternating with shale. Analyses may be found in a table at the close of this description.

There is but one place where the limestone is quarried extensively. That location is in the Bossardville Limestone 0.8 mile west of Ruddle. Here the Bossardville is 481 feet

[2]For map of outcrops of Silurian Limestones see Figure 20.

PLATE LXXVIII. Marl deposited over Rondout. The location is on Friends Run, half a mile east of Friends Run School. (Photo. by John L. Tilton).

thick, dipping 33° southeast and outcropping along the road for a distance of 883 feet, with the dark, shaly Rondout 430 feet thick upon the west and the dark thick-bedded Keyser of the Helderberg upon the east. The Bossardville beds may be grouped into four divisions as follows:

	Feet.
Limestone, mostly thin-bedded, to Keyser crinoidal layer east	340
Limestone, shaly, the upper part east of kiln	48
Limestone, crinoidal, lower part at the kiln	46
Limestone, shaly, thin-bedded, west of kiln	47
Total	481

Mr. D. R. Keplinger now operates the plant. (See Plate XXXVI, page 129). In 1925 he had up to July burned two kilns, and expected to burn two more before winter. The farmers had taken it all for their land, except a little for one building in Franklin. This plant is well located to supply the needs of all living along South Branch, and, with the good roads now completed and under construction, may well supply the needs of the entire county. The limestone used is good, not only for lime for land and building purposes but also for cement. Lack of coal and of oil or gas makes competition with distant manufacturers of cement unprofitable, but there is need of lime for the land and for building purposes, affording a home market which should constantly increase.

Marl.—Marl is a form of calcium carbonate due to evaporation of water charged with calcium bicarbonate. Most of such lime-laden water escapes to the rivers, but occasionally, flowing over rocks, moss grows in such an abundance that evaporation of water is favored, which in turn leads to an accumulation of this soft porous limy deposit. Because it is so easily broken up it is a valuable source of lime for land wherever such deposits exist. It forms on slopes below the beds of limestone, and near springs. A good illustration may be seen on Friends Run half a mile east of Friends Run School.

For building purposes other than lime and cement, the various dense beds will answer for underground foundations,

though blocks of sandstone are more suitable. Shaly limestone is too easily disintegrated to be acceptable for this purpose. For courses above ground the question of color is involved. Many of the limestones are dark, giving a somber color effect. Where the color is satisfactory rocks from the heavy beds that have long withstood the processes of weathering may be relied upon for building. Unchecked masses of satisfactory color can be cut for sills and lintels. While much of the limestone is dense there is none that has been changed into marble.

For data with reference to road material see special heading.

Analyses of Pendleton County Limestones, by B. B. Kaplan, Chemist.

	1.	2.	3.	4.	5.	6.	7.
Silica (SiO_2)	4.90	8.60	9.20	11.70	51.10	3.40	3.20
Ferric Iron (Fe_2O_3)	0.42	0.36	0.76	0.61	1.03	0.37	0.41
Alumina (Al_2O_3)	0.78	1.54	1.60	8.20	2.27	0.63	1.79
Calcium Carbonate ($CaCO_3$)	92.62	86.73	87.80	78.82	42.80	94.41	93.87
Magnesium Carbonate ($MgCO_3$)	0.61	0.86	0.42	0.40	1.80	0.38	Trace
Phosphoric Acid (P_2O_5)	Trace	0.01	0.025	0.02	0.05	0.01	0.24
Loss on ignition	0.74	0.84	0.61	0.38	0.79	0.67	0.42
Totals	100.07	99.94	100.415	100.13	99.84	99.87	99.93

	8.	9.	10.	11.	12.	13.	14.
Silica (SiO_2)	2.00	2.40	3.24	6.38	2.78	4.70	1.00
Ferric Iron (Fe_2O_3)	0.13	0.24	0.68	0.48	0.69	0.33	0.12
Alumina (Al_2O_3)	0.37	0.36	0.80	0.92	0.81	0.39	0.37
Calcium Carbonate ($CaCO_3$)	97.40	95.12	94.27	91.12	93.72	93.25	98.40
Magnesium Carbonate ($MgCO_3$)	Trace	0.01	0.28	0.38	1.10	0.77	0.13
Phosphoric Acid (P_2O_5)	0.41	0.80	0.01	Trace	0.01	0.011	Trace
Loss on ignition	0.21	0.78	0.38	0.54	0.63	0.41	0.12
Totals	100.52	99.71	99.66	99.82	99.74	99.861	100.14

	15.	16.	17.	18.	19.	20.	21.
Silica (SiO_2)	6.90	2.00	2.05	29.10	93.80	6.30	17.30
Ferric Iron (Fe_2O_3)	0.81	0.28	0.38	0.88	2.76	0.16	0.20
Alumina (Al_2O_3)	0.97	0.42	0.82	1.80	0.54	0.84	1.80
Calcium Carbonate ($CaCO_3$)	90.48	93.25	95.48	68.00	1.60	90.30	76.73
Magnesium Carbonate ($MgCO_3$)	0.13	3.60	0.67	0.48	....	0.71	1.26
Phosphoric Acid (P_2O_5)	Trace	0.015	0.015	0.021	0.025	0.03	0.03
Loss on ignition	0.18	0.48	0.67	0.15	1.10	1.47	2.30
Totals	99.47	100.045	100.085	100.431	99.825	99.81	99.62

	22.	23.	24.	25.	26.	27.	28.
Silica (SiO_2).......	2.30	21.62	68.60	21.94	55.80	7.90	71.10
Ferric Iron (Fe_2O_3)	0.44	1.23	4.33	0.91	1.60	0.67	2.40
Alumina (Al_2O_3)....	1.06	1.77	2.97	0.89	2.00	0.63	2.60
Calcium Carbonate ($CaCO_3$)	96.01	74.20	24.25	76.10	38.90	89.40	22.85
Magnesium Carbonate ($MgCO_3$).....	0.10	1.25	0.13	0.15	0.41	0.61	0.32
Phosphoric Acid (P_2O_5)	0.01	0.060	0.081	0.076	0.064	0.019	0.058
Loss on ignition...	0.10	0.32	0.31	0.28	1.18	0.31	0.71
Totals.........	100.02	100.45	100.671	100.346	99.954	99.539	100.038

	29.	30.	31.	32.	33.	34.	35.
Silica (SiO_2)...........	21.62	34.90	6.10	30.34	10.40	5.50	3.00
Ferric Iron (Fe_2O_3)....	1.23	2.50	0.42	2.80	0.88	0.62	0.12
Alumina (Al_2O_3)........	1.77	2.70	2.88	2.60	1.82	0.88	0.42
Calcium Carbonate ($CaCO_3$)	74.20	58.35	87.43	57.60	74.20	92.20	94.33
Magnesium Carbonate ($MgCO_3$)	1.25	0.41	1.10	4.10	8.37	0.38	2.05
Phosphoric Acid (P_2O_5)	0.060	0.031	0.04	0.05	0.057	Trace	0.005
Loss on ignition.......	0.32	0.64	0.81	2.40	4.00	0.49	0.32
Totals.............	100.45	99.531	99.78	99.89	99.727	100.07	100.245

Limestone No.

1. T. L. 29, Lab. No. 3007. Niagara (McKenzie) Limestone, from one-half mile northwest of Dahmer.
2. T. L. 30, Lab. No. 3008. Niagara Limestone, from 0.2 mile east of Friends Run School.
3. T. L. 2, Lab. No. 2961. Niagara Limestone, from Dry Run one mile above its mouth, near North Fork Church.
4. T. L. 31, Lab. No. 3009. Rondout Limestone, from Hammer Run, 2.1 miles northwest of Ruddle.
5. T. L. 1, Lab. No. 2960. Bossardville Limestone, from Dry Run, 0.9 mile above its mouth, near North Fork Church.
6. T. L. 32, Lab. No. 3010. Bossardville Limestone, from D. R. Keplinger quarry on Hammer Run, 0.8 mile northwest of Ruddle; from the lowest division near the kiln.
7. T. L. 33, Lab. No. 3011. Bossardville Limestone, from D. R. Keplinger quarry on Hammer Run, 0.8 mile northwest of Ruddle; from the upper part at kiln.
8. P. H. 7, Lab. No. 2974. Bossardville Limestone, from D. R. Keplinger quarry, 15-foot ledge back of kiln.
9. P. H. 14, Lab. No. 2990. Bossardville Limestone, D. R. Keplinger quarry, from 15-foot ledge back of kiln.
10. P. H. 12, Lab. No. 2988. Bossardville Limestone, D. R. Keplinger quarry, from 15-foot ledge back of kiln and 15-20 feet east.
11. P. H. 15, Lab. No. 2991. Bossardville Limestone, D. R. Keplinger quarry, from near center of Bossardville east of kiln.
12. P. H. 13, Lab. No. 2989. Bossardville Limestone, D. R. Keplinger quarry, from back of kiln and about 25 feet above it.
13. P. H. 10, Lab. No. 2977. Bossardville Limestone, from Mervin Simmons farm three-fourths mile southwest of Moser Knob.
14. P. H. 8, Lab. No. 2975. Bossardville Limestone, near its base, Props Run one-half mile northeast of Props Knob.
15. P. H. 11, Lab. No. 2987. Bossardville Limestone, one-half mile northeast of Totten Chapel.
16. T. L. 4, Lab. No. 2964. Keyser Limestone, Dry Run, 0.8 mile from its mouth, near North Fork Church.
17. T. L. 34, Lab. No. 3012. Coeymans Limestone, second layer from top, 1.5 miles west of Oak Flat.
18. T. L. 3, Lab. No. 2963. New Scotland Limestone, Dry Run, three-fourths mile from its mouth, near North Fork Church.
19. T. L. 35, Lab. No. 3014. New Scotland Limestone (?), Reeds Creek, 0.8 mile southwest of Upper Tract.
20. T. L. 37, Lab. No. 3015. Selinsgrove Limestone, near level of road, one-half mile south of Sugar Grove.

21. T. L. 36, Lab. No. 3013. Selinsgrove Limestone, 1.3 miles south of Sugar Grove.
22. P. H. 17, Lab. No. 2986A. Selinsgrove Limestone, three-fourths mile south of Sugar Grove.
23. T. L. 14, Lab. No. 2977. Greenbrier Limestone, east side of Roaring Creek, 0.9 mile north of Onego, 2 miles south of Roaring School. Sample (1) from base near mill (Fredonia Limestone).
24. T. L. 8, Lab. No. 2968. Greenbrier Limestone, east side of Roaring Creek, 1.15 miles north of Onego, 1.75 miles south of Roaring School. Sample (2) from 7-foot limestone 52 feet above the valley and 93 feet above base at mill.
25. T. L. 9, Lab. No. 2969. Greenbrier Limestone, east side of Roaring Creek (as above). Sample (3) from the 15-foot ledge immediately above No. 24.
26. T. L. 10, Lab. No. 2970. Greenbrier Limestone, east side of Roaring Creek (as above). Sample (4) from the 11-foot dense limestone 10 feet above No. 25.
27. T. L. 11, Lab. No. 2971. Greenbrier Limestone, east side of Roaring Creek (as above). Sample (5) from the 26-foot bed of blue limestone 21 feet above No. 26.
28. T. L. 12, Lab. No. 2972. Greenbrier Limestone, east side of Roaring Creek (as above). Sample (6) from the 34 feet of red limestone 26 feet above No. 27.
29. T. L. 7, Lab. No. 2967. Greenbrier Limestone, east side of Roaring Creek (as above). Sample (7) from 41 feet above No. 28. (Samples 2 to 7 are from the Gasper, Upper Union, division of the Greenbrier Series).
30. T. L. 13, Lab. No. 2973. Greenbrier Limestone, east side of Roaring Creek (as above). Sample (8) is from the dense blue fossiliferous limestone (Glen Dean) 46 feet above No. 29.
31. T. L. 38, Lab. No. 3016. Reynolds Limestone, Long Run, at 2880 feet A. T.
32. T. L. 15, Lab. No. 2978. Hinton (Avis) Limestone, lowest layers, Long Run.
33. T. L. 16, Lab. No. 2979. Hinton (Avis) Limestone, 20 feet above No. 32, Long Run.
34. T. L. 17, Lab. No. 2980. Hinton (Avis) Limestone, top of limestone 20 feet above No. 32.
35. T. L. 41, Lab. No. 3054. Stones River Limestone, Ordovician, one mile southeast of Judy Spring.

SHALE AND CLAY.

Shale is the name applied to ancient mud laid down in layers and long since hardened into the beds that we now find. There are several varieties of shale. Some of it is nearly pure clay (essential constituent, kaolin, $(H_4Al_2Si_2O_9)$, hence called argillaceous or clayey shale. Some of this clayey shale is light in color, some blue, green, yellow, red, black, depending on ingredients that are mixed in with the clay. Chief of these accessories are forms of iron, especially hematite, red, Fe_2O_3, and limonite, yellow, $Fe_2O_3.3H_2O$. Where lime in the water reduces the iron to the ferrous state (FeO) the shale assumes a greenish shade. Where carbon is present it assumes various shades from blue to black, depending on the amount of carbonaceous matter. Where the clay is mixed with sand it is called an arenaceous or sandy shale. Of this there are all grades between a clayey shale and a sand, the various colors dependent on the amount of iron oxide present. When the clay has somewhat of lime $(CaCO_3)$ in its composition it becomes a calcareous shale. Of this there are all grades between a limy shale and a shaly limestone. The limy shales are apt to be fossiliferous, for it is the shells of ancient animals and the lime from lime-secreting seaweeds that have supplied the

lime. Not so, however, with the blue, green, yellow, and red shales. They are rarely fossiliferous, and the black shale rarely has more than plant fragments.

Washed from the beds of shale and transported by streams, the water-soaked shaly material settles in quiet places as beds of mud. In the old valley deposits now high and dry the products from shale still remain in the terraces. Beds of clayey shale, and clayey deposits are the materials for brick and tile, but the black mud deposited in quiet places along streams is rarely pure enough clay to be of use for brick. If there is a great abundance of vegetable material (muck) it may be used to enrich the soil. Shale is generally so hard to work that machinery is used to grind, mix, and mould it, but the clays of terrace deposits can be worked by hand. Whether the brick shall be soft or hard depends on the material, the force applied in the moulding, and the heat applied in firing.

On the terrace just northeast of Franklin, on land owned by Dr. Dyer and the Bowman Brothers, the clay at the surface of the terrace has been made into brick by Mr. C. B. Smith of Bridgewater, Virginia, who burns the brick as needed. The price is $45 per thousand laid in wall.

Shale is in various formations throughout the county, and terrace deposits line the river valleys, but the cost of machinery and the present size of the market leaves for the future an up-to-date plant for brick and tile. In a region that is so mountainous there is not the demand for tile that there is in a level country, and the increasing transportation facilities bring the best of ceramic products in easy reach.

SANDSTONE, SAND, AND GRAVEL.

The sandstone of the county consists of rounded grains of quartz (silica) cemented together largely by silica, lime, and oxide of iron. Its strength is dependent on the manner and completeness of the cementation; its color, upon the included material. The White Medina consists of rounded grains of quartz, sometimes large enough to form a conglomerate, cemented together by quartz, to the purity of which is due the

whiteness of the rock, forming the most durable and the strongest rock in the county. The Red Medina and the Clinton Sandstones owe their color to the abundance of hematite that has been washed in with the sand or has infiltrated the mass after the deposition of the sand.

The Oriskany Sandstone also owes its brownish-red color to the presence of oxide of iron. Often this sandstone is so poorly cemented that it readily disintegrates, leaving the ground around strewn with sand of rounded grains. To this is due the abundance of sand on Sandy Ridge. The grayish sandstone layers in the Portage and Chemung contain relatively small amounts of hematite, but the heavy beds of Catskill sandstone, of Pocono and of Mauch Chunk in the western part of the county, have their color due to the large amount of iron oxide that they contain. So abundant is the amount of iron oxide and so universal is its distribution that it is looked upon as an indication of arid conditions during the time of its deposition. Near the top of the Mauch Chunk and in the Pottsville are white sandstones cemented by silica, some coarse enough to be considered conglomerates. Thus the sandstones of the county present all shades of color, white, gray, yellowish-brown and red, all degrees of fineness up to that of a conglomerate, all degrees of resistance to weathering from that of a shaly sandstone to that of a quartz rock that is nearly a quartzite, and all degrees of strength from the loosely cemented sandstone that can be crushed in the hand to the strongest sedimentary rock. There is no granite in the county, and no rock that is classified as a crystalline, excepting the small patch of weathered volcanic breccia west of Bull Pasture Mountain.

In distribution, all parts of the county are well supplied. Along the axes of the great anticlines and capping their summits is the White Medina. On the flanks of lower ridges, especially northeast-southwest through the central half of the county are the brownish Oriskany Sandstones. On the high ground in the eastern parts of the county is the reddish-brown Catskill sandstone and in the western part the Pocono, Chemung, Catskill, and Mauch Chunk beds of reddish-brown stone. The Pocono (Purslane) and the Portage and Che-

PLATE LXXIX.—This building represents a complete geologic column of the more resistant rocks of Pendleton County from the Pottsville to the Ordovician. (Photo. by Paul H. Price).

mung in the eastern part of the county are gray, the Portage especially supplying an abundance of flagstone, suitable for walks and cheap masonry.

From such a varied assemblage can be chosen whatever in color, strength, durability, and thickness of bed seems best suited to the work in hand. Most generally it will be foundation stone, to be laid in cement.

What is possible in choice of material is well illustrated at the law office of H. M. Calhoun, Esq., of Franklin, who has selected resistant rocks from all parts of the county, representing the various Series from the Ordovician to the Pottsville in the construction of this interesting building (Plate LXXIX).

Sand and gravel, so essential for plaster and cement, lie along Oriskany ridges. In the weathering of the various sandstones the grains of silica are loosened, then washed into the runs and rivers where they lodge in pockets. Here in different spots gravel of all sizes is available. Oriskany hillsides especially are strewn with fragments of sandstone. On Sandy Ridge there is a supply to excess, already washed clean by the elements, suitable for glass-sand if only located where manufacture were profitable.

ROAD MATERIAL.

Road material of all kinds is near at hand in all parts of Pendleton County. Particularly is this true along the main valleys. Resistant sandstone from the Oriskany and chert from the Helderberg make a good base, on which to place crushed stone and then to surface with shale. As a result a fine oiled-shale road now connects Franklin and Petersburg and other towns farther north, and the road is being extended south beyond the limits of the county. The roads along North Fork and South Fork are not yet improved roads. In crossing the mountains not only is there a difficulty in finding suitable grades but also in constructing roads along and through such resistant rock as the White Medina. Even in the face of these difficulties it is possible to cross from Franklin to the valley of North Fork by an excellent

road, and by a good dirt road at a considerable distance to the south. It is also possible to go on an excellent road from Franklin to Oak Flat and then from Brandywine east over Shenandoah Mountain. By another route not so good one may go via Moyer Gap to Sugar Grove and then over Shenandoah Mountain east. The era of good roads has arrived. More and more will access to all parts of the county become easy.

In developing the roads the State Road Commission has made a series of analyses and tests, which are available through the kindness of Messrs. R. B. Dayton and Fred A. Davis of the Testing Department of the State Road Commission, Morgantown, West Virginia:

Road Material Analyses, Pendleton County, by Testing Department, State Road Commission.

Number.

3461A Limestone. April 25, 1923. Project 876.

	Per cent.
Silica	47.96
Alumina and iron oxide	2.50
Calcium carbonate	47.50

4323A Limestone. June 28, 1923. Project 3175

Calcium carbonate... 83.00 per cent.

4637A and 4638A Chert. July 13, 1923. Project 3175A, Franklin-Elkins.

	Per cent.
Volatile	3.66
Alumina and iron oxide	3.66
Calcium carbonate	1.27
Magnesium carbonate	0.70
Silica	90.01

5203A Calcareous sandstone. Aug. 14, 1923.
Project 3014, Upper Tract Bridge.

Calcium carbonate.... 18.7 per cent.

5282A Limestone. Aug. 20, 1923. Project 3142A, Franklin-Brandywine.

Calcium carbonate.... 94.0 per cent.

5430A Rock. Aug. 31, 1924. Project 3014, Upper Tract-Grant line.

Calcium carbonate.... 30.8 per cent.

7401A Limestone.

Calcium carbonate.... 76.2 per cent.

7413A Gravel, Chert and Clay. March 22, 1924. Project 3142A.

	Mixture. Per cent.	Sample of Rock. Per cent.
Silica	80.00	93.56
Alumina and iron oxide	15.86	2.87
Calcium oxide	0.50	1.00
Volatile	3.34	0.80

7414A Gravel, Chert and Clay. March 22, 1924. Project 3142A.

	Mixture. Per cent.	Sample of Rock. Per cent.
Silica	78.6	88.4
Alumina and iron oxide	15.9	8.4
Calcium oxide	0.56	1.1
Volatile	4.46	1.7

7454A Gravel, Cletus Shrader. April 8, 1924.
Project 3175A, Franklin-Elkins

	Per cent.
Calcium carbonate	46.50
Silica and silicates	46.40
Alumina and iron oxide	2.96

Seven or eight pieces were taken for analysis. This material is a mixture of chert and limestone. Chert and limestone are generally found in the same piece of rock.

13993A Shale. March 31, 1926. Project 3208A, Franklin-Brandywine.

	Per cent.
Oven loss (@ 100° C.)	1.1
Loss on ignition	6.0
Silica	59.8
Iron oxide	7.1
Alumina	22.2
Calcium oxide	trace
Magnesium oxide	0.9

13993A Shale. March 3, 1926. Project 3208A, Franklin-Brandywine.

	Per cent.
Oven loss (@ 100° C.)	1.1
Loss on ignition	5.7
Silica	64.0
Iron oxide	5.8
Alumina	19.1
Calcium oxide	trace
Magnesium oxide	1.2

13995A Sandstone. Project 3208A, Franklin-Brandywine.

	Per cent.
Silica	71.80
Iron oxide	14.50
Alumina	10.00

A sandstone with a high percentage of iron and alumina oxides.

14043A Shale. Project 3213A, Franklin-Monterey.
Shale 1. Right of way. Quantity represented, 1000 cu. yds. Submitted by W. T. Tibbets, Franklin, W. Va. Sampled Feb. 20, 1926, right of station 176+00. March 2, 1926.

	Per cent.
Silica	60.00
Iron oxide	6.59
Alumina	21.13
Calcium oxide	1.18

	Per cent.
Magnesium oxide	1.30
Loss on ignition	6.16
	96.36

14044A Shale. Project, 3213A, Franklin-Monterey. Shale 2. Right of Way. Quantity represented, 2000 cu. yds. Submitted by W. T. Tibbets, Franklin, W. Va. Sampled Feb. 20, 1926, right of station 189+00. March 2, 1926.

	Per cent.
Silica	57.58
Iron oxide	7.56
Alumina	20.98
Calcium oxide	0.68
Magnesium oxide	1.14
Loss on ignition	6.25
	94.19

14045A Shale. Project, 3213A, Franklin-Monterey. Shale 3. Right of Way. Quantity represented, 500 cu. yds. Submitted by W. T. Tibbets, Franklin, W. Va. Sampled Feb. 20, 1926, right of station 126+00. March 2, 1926.

	Per cent.
Silica	56.86
Iron oxide	8.20
Alumina	22.76
Calcium oxide	0.73
Magnesium oxide	1.48
Loss on ignition	6.07
	96.10

14046A Shale. Project 3213A, Franklin-Monterey. Shale 4. Right of Way. Quantity represented, 1500 cu. yds. Submitted by W. T. Tibbets, Franklin, W. Va. Sampled Feb. 20, 1026, right of station 109+00. March 2, 1926.

	Per cent.
Silica	54.20
Iron oxide	6.75
Alumina	23.47
Calcium oxide	2.70
Magnesium oxide	1.02
Loss on ignition	8.35
	96.49

14047A Shale. Project 3213A, Franklin-Monterey. Shale 5. Right of Way. Quantity represented, 3000 cu. yds. Submitted by W. T. Tibbets, Franklin, W. Va. Sampled Feb. 20, 1926, right of station 83+00. March 2, 1926.

	Per cent.
Silica	58.40
Iron oxide	6.59
Alumina	19.51

Road Material Tests, Pendleton County, by Testing Department, State Road Commission.

Serial Number	Source	Specific Gravity	Weight per Cu. Ft. Lbs.	Absorption Lbs. per Cu. Ft.	Abrasion Per cent. wear	Hardness Coefficient	Toughness. Height blow cms.	Project Number	Kind of Rock	Type of Construction
2759	D. F. Bowers................	2.72	169.7	......	3.00	....	....	3175	LS	General use
2760	J. K. Kee..................	2.55	159.9	1.62	2.24	....	....	3175	SS	General use
3048	Dice Property, Franklin, W. Va..	2.35	147.0	4.30	22.66	....	....	3142	SS	Masonry
3461	Upper Tract, W. Va...........	2.68	167.24	......	1.98	Soundness O. K.	....	Br. 876	LS	Concrete
4323	Circleville, W. Va............	2.66	165.99	......	6.28	....	....	3175	LS	Concrete
5203	Upper Tract, W. Va...........	2.705	168.79	......	2.50	Soundness O. K.	See analysis	3014, 876	SS	B. Conc.
5282	G. W. Hammer...............	2.60	162.24	......	6.76	Soundness O. K.	....	3142A	LS	B. A. Conc.
5430	C. N. Judy..................	2.685	167.55	......	2.22	See analysis	....	3014	Cal. SS	Class B. Conc
7302	B. H. Hiner, Franklin, W. Va...	2.415	150.69	4.1	17.72	....	....	3175D	SS	Agg. for Conc.
7401	Franklin, W. Va..............	2.72	169.73	......	2.32	....	....	3142A	LS	Mac. Surf.
7527	P. Boggs Property............	2.63	164.12	......	2.78	....	....	3142A	SS	A. and B. Conc.
9130	....	2.51	156.62	......	Mech. anal.	....	....	3175B	SS	A. B. C. Culverts
11409	Right of Way................	2.63	164.12	......	1.64	....	....	3175B	SS	General
13080	J. E. Moyers, Franklin, W. Va..	2.65	165.36	......	3.6	....	....	3213A	SS	A. B. and C. Conc.
13806	Right of Way................	2.58	101.00	......	3.4	....	....	3175C	SS	A. B. and C. Conc

Calcium oxide	1.13
Magnesium oxide	1.30
Loss on ignition	7.79
	94.72

18384A and 18385A Shale. Project 3208A, Franklin-Brandywine. These two samples of shale were submitted by A. D. McReynolds, Franklin, W. Va., Oct. 13, 1926. 18384A was from a point 1000 feet left of station 450+25, bank of county road, 1000 feet north of Oak Flat, while 18385A was from station 387 to 391.

	18384A. Per cent.	18385A. Per cent.
Oven loss (@ 100° C.)	0.92	0.74
Loss on ignition	6.48	6.53
Silica	63.33	54.66
Iron oxide	3.92	6.60
Alumina	21.45	22.61
Calcium oxide	trace	2.62
Magnesium oxide	0.66	0.73
	96.76	94.49

WATER[3] FOR DOMESTIC PURPOSES.

Of this most necessary mineral there is an abundant supply in Pendleton County. From every mountainside precipitation is turned toward the three main rivers, the flow of which is also maintained from areas south of the county. Thus there is a never-failing supply along these main arteries. So, too, along the main tributaries there is a constant supply due to precipitation in large drainage areas. Even along the smaller runs that may go dry at times there is the best of water easily obtainable from springs and wells.

Much of the precipitation does not immediately join the run-off but sinks into the ground, along the loose colluvial soil of the mountainside and valley, along the sandstones and porous sandy shale, and along fissures in the sandstone and limestone, from which it comes to the surface farther down the valley. The term dry run is hardly appropriate. Only short stretches of such a valley are dry, and then only in specially dry seasons when all the drainage is accommodated by underground channels for a short distance. That distance

[3]Precipitation and water-power are treated elsewhere.

is never very great, for, excepting a few rods at Circleville in very dry weather, the rivers contain too much water to thus disappear, and the main tributaries cross the folds, so that fissured strata letting the water into the ground allow it to come to the surface again not far down the valley.

The limestone beds especially favor the formation of underground passageways. The limestone itself is gradually soluble in rain-water, for rain-water and surface water from areas covered with vegetation carry in solution carbon dioxide that acts upon the limestone converting the calcium carbonate of the limestone into calcium bicarbonate, which is really soluble. Thus cracks in the limestone are widened out by solution. Insoluble particles that are loosened in this process are carried along by the water, and the clayey layers exposed in the limestone are washed out. Thus underground passageways are formed in limestone areas. How common this is is emphasized by such names as Dry Run, Cave, Cave School, and Cave Mountain. Trout Cave and Smoke Hole Cave are passageways dissolved out in this manner along streams that formerly flowed at their level..

Any of the limestones may afford passageways for such underground streams, but the area which is most favorable is the large area southwest of Franklin, where streams such as Smith Creek cross the Bossardville and Helderberg Limestones.

Along Wills Mountain Anticline in the Cave School area erosion has cut down into the Stones River Limestone of the Ordovician, in a region that is upheaved, broken, and faulted. Here sink-holes are to be seen where the rainfall disappears beneath the surface, and underground passageways may be seen exposed in road construction. At Judy Spring a large volume of water wells out and flows as a rivulet to North Fork.

A few rods above the bridge at Circleville the water disappears in crevices in the Bossardville Limestone, only to enter North Fork again half a mile below.

West of North Fork the limestone that favors the formation of these underground passageways is the Greenbrier Limestone. North of Onego the bed of Roaring Creek becomes dry for about a mile. The water that has thus dis-

appeared then gushes from a cave in the mountainside, where formerly it was caught in a flume and conducted above the channel of the creek to a mill where this portion of the water was put to good use to run a grist-mill. About opposite and north of where the water of Roaring Creek enters the ground the east side of the valley is lined with springs where water comes from limestone crevices. So, too, at Ketterman Mill (see Plate XI, page 54), on Brushy Run, water issuing from an underground passageway has for many years turned an overshot wheel.

Water that finds its way along fractures in Oriskany Sandstone does not develop such large passageways as may be formed in limestone, for the silica of the sandstone and the other binding material of the rock are not so soluble as the limestone. The porosity of the sandstone combined with the space in fractures accommodate so much water that springs along the Oriskany beds are readily found and shallow wells are obtainable, especially in low ground where the top of the Marcellus Shale is just beneath the soil, for beds of shale are more impervious to water than are beds of sandstone. A good illustration of a spring found under such conditions is by the roadside near Crummet Church.

The same principle applies to other sandstones, but of the sandstones the Oriskany is the best water-carrier.

Where water passes along fissures and bedding-planes in Hamilton Shale for any considerable distance the water that issues from the shale is sulphurous, due to the decomposition of iron sulphide that the shale contains.

Thus in the farm land along all the rivers, creeks, and larger runs, springs and wells of good water free from contamination of surface flow may easily be obtained. Flowing water, even in mountain runs, is to be viewed with suspicion as the number of stock and the population increase. While such water is to be avoided for drinking purposes it is excellent for other domestic uses, particularly the soft water that comes from areas of sandstone.

A word of caution here may not be out of place. Even the springs and the wells should be kept clean, and so protected that no animal and no impurity can get into the water

from above, or drain in along the ground. Too much care can not be taken to keep the household supply free from all contamination, for without sufficient care the water-supply becomes a source of disease. Stock also profit by the care of those who keep watering-troughs clean and supplied with good water. River water can be made safe by a process known as chlorinization, but the method is too complicated for ordinary use in the home. Boiling impure water may be resorted to when necessary, but it is better to choose a good source when good conditions are so common as they are in Pendleton County, and keep that source pure.

There are two towns with municipal water-supplies. At Circleville a local arrangement was made that resulted in a municipal plant. Water from a pool in Bouses Run is piped 3,000 feet down the valley to the town, giving a head of water 200 feet above the main street in Circleville. Mr. Warner informs me that this cost but $3,000, which was divided among the citizens, that 1,000 feet of laterals had been put in, supplying 7 hydrants and 20 families, each householder attending to his own plumbing, so that the project is out of debt and the water is now free. They are expecting to put in a dam later. This style of a municipal enterprise serves as a model to all small communities.

At Franklin river water is pumped into a reservoir located on a hill southwest of the town at an elevation of 128 feet above the main street. Shortly after the fire that swept the town in 1924, the use of the leaky cement reservoir was discontinued and a steel tank of 150,000 gallons capacity was installed. The city owns its own machinery consisting of the tank mentioned, the mains, and a triplex pump, 5 x 8, manufactured by the Gould Manufacturing Company of Seneca Falls, N. Y. This pump, with speed used, pumps 91 gallons per minute. The amount of water required varies from 2,100,000 gallons to 2,800,000 gallons for three months, thus averaging from 23,000 to 31,000 gallons per day. The pumping outfit, installed in 1905 at an original cost of $7,000, has been used continuously with almost no expense for repairs up to the present time. While the city owns the outfit the

water-power is owned by Mr. Paul R. Priest, whom the city employs to operate the plant. The city pays four cents per thousand gallons for pumping the water and charges twenty-five cents per thousand for delivery. The plant would now be out of debt but for an attempt to erect a dam which washed out causing considerable loss. There are now 18 fire hydrants and 75 homes at which city water is available.

Formerly the water was tested every two weeks and reported pure. Later it was tested every three weeks with the same result; so testing of the water is at present discontinued.

THE SOILS.

The soils of the county are such as are found in the Appalachian Mountain and Plateau Province.

The term soil properly applies to the dark weathered material in which the plants grow. It consists of weathered mineral matter with dark carbonaceous material scattered through it, the products of decay, forming humus. This material of organic origin becomes less abundant downward until only the weathered mineral matter appears, the subsoil. The soil is thin on high ground subject to erosion, thicker on the lower slopes where the gradual movement or creep of the loose material (regolith) including the soil gives a colluvial soil, and thickest along the flats where high water leaves the soil as an alluvial deposit. On the terraces are these old alluvial deposits now all drained, fertile stretches of choice ground, easily worked, and very productive. Such broad stretches along the river valleys are continued up various creeks and runs narrowing to the point where erosion in time of flood equals deposition. This level land is the choice land of the county.

Inasmuch as the weathering of the rocks determines the mineral constituents of the soil it is evident that at the place of origin there will be as many variations in the character of the soil as there are variations in rock weathering. Where it is a sandstone like the White Medina, the Pottsville, or the Oriskany, the product will be sandy, its abundance dependent on the ease with which the rock weathers and the opportunity

for wind and water to remove the weathered product. In this material will be finer particles from shale and sandstone held in spaces between the fragments of coarser material before the sorting power of erosion proceeds. Such soil is spoken of as of the Dekalb Series: surface soil gray, subsoil yellowish, a well-drained upland soil from non-calcareous shale and sandstone. This, it will be recognized, is the soil of the sandstone highlands where the sandstone extends above the belt of limestone. It is the soil adapted to forests and nothing else, except as sheep and goats may wander cropping the scattered grasses.

Where there is a pure limestone like the New Scotland above the drainage line, the products of decay go off in solution leaving only the insoluble chert; but where the limestone contains impurities along with the lime as most limestones do, as the Rondout, the Bossardville, and the Keyser, and the lime is dissolved out, it leaves the insoluble residue of chert and clay to be washed by the rains here as elsewhere. This character of a residue is classed in the Hagerstown Series. It is reddish brown in color from the decomposition of the impure limestone. It is the soil of the Hunting Ground region. Its areas are generally narrow, the width depending on the width of the strata, narrow where the dip is steep, wider where the dip is less steep; and on the slope of the surface, narrow where the ground is high above the near-by drainage lines, wider where the limestone is at the level of the valleys; but if yellowish, heavy, and impervious on these lower slopes, the soil is referred to the Lickdale Series.

Where red shales and sandstones are yielding to the weather, a soil of clay and fine silica mixed is the result, which, forming readily, lies in wide valleys, as in areas of Catskill and Mauch Chunk. Where there are not overlying high rocks maintaining a high upland the valleys formed are wide. Since generally there is somewhat of limestone in beds here and there in the shale the weathered product is somewhat calcareous. Such a soil is classed in the Upper Series: as reddish soil and subsoil, from red shale and sandstone, somewhat calcareous. In this county it finds its best expression in the Mauch Chunk area along Spruce Mountain.

In the terraces where the surface soil is yellowish-brown,

subsoil red, gravelly and well drained, the soil is classed in the Elk Series. If it is a gray soil, mottled bluish-gray subsoil, well drained and of porous material worked from Dekalb areas, it is classed as in the Holston Series. The poorly drained bottom slopes in old drainage ways are referred to the Tyler Series.

The well-drained alluvium of bottom land in a region where there is so much limestone as here, belongs to the Huntington Series. The poorly drained alluvium is in the Holly Series.

No survey has yet been made to determine how many acres of each class of soil there are and where each patch is located, but the above description gives, it is hoped, what is needed for a general recognition of the main types. The soil survey by experts of the U. S. Bureau of Soils will be made later and a separate map and report will be issued by the U. S. Department of Agriculture.

A further recognition of soil classes or types is based on the size of the mineral grains and their relative abundance. In fine gravel the grains are between 2 millimeters and 1 millimeter in diameter. In coarse sand the diameter ranges between 1 mm. and 0.5 mm.; in medium sand, between 0.5 mm. and 0.25 mm.; in fine sand, between 0.25 mm. and 0.1 mm.; in very fine sand, between 0.1 mm. and 0.05 mm.; and in silt, 0.05 mm. to 0.005 mm. Below that size it is a clay. Soil with 20 per cent. silt and clay is sandy, of the various grades. Soil with 20 per cent. to 50 per cent. silt and clay is sandy loam or sandy clay, and soil containing 50 per cent. or more of silt and clay is a loam, unless it is all clay.

Good land is readily recognized. The early settlers chose the level ground along the rivers and the larger tributaries for their homes. Those regions, especially the terrace land, are now rich in wheat, oats, and corn. No tract here is seen marked "for sale". The higher grounds furnish pasturage and timber now, as in earlier years they furnished timber and game. The stony highlands are still the regions for timber, as truly a crop as any other, and one on the conservation of which the value of the soil in a large measure depends. Conservation includes wise cropping.

FOREST CONDITIONS.

The Original Forest Conditions.—Mr. A. B. Brooks, State Forester, describes as follows the original forest conditions[4] in Pendleton County:

"With a vertical range in altitude of more than 3,500 feet this county becomes the natural home of a great variety of trees and shrubs and other plants. In the rich river valleys grew many hardwoods such as the oaks, the maples, the walnuts, and the yellow poplar; while on the cold summits of the highest mountains where the original conditions still exist only such species as can endure a Canadian climate find a congenial home. Among these are the red spruce, the mountain ash, the yellow birch, and the mountain maple. There is no indication at present that red spruce was abundant on any of the high ridges east of Spruce Mountain, although the elevation would seem to favor its growth in many places. White pine was once common in the creek bottoms of the tributaries of the South Branch and the South Fork. A few groves of this tree still remaining in the river valleys indicate that it once may have grown in similar situations throughout the county. The other conifers were hemlock, yellow pine, pitch pine, jersey pine, table mountain pine, red cedar, and arbor vitae. Of these yellow pine was once abundant, growing principally on southern and eastern exposures. Yellow poplar has never grown generally in this area, but that it was once found in South Branch Valley, at least to some extent, is evidenced by the fact that some of the old log houses built in Revolutionary times were constructed of this wood."

Since the Report quoted was written lumbering has proceeded along the headwaters of Seneca Creek, observatories from which to watch for fires have been established on Spruce Knob and on Shenandoah Mountain, and large areas in both regions included in the National Forest. Even with these improvements it is well to note what Mr. Brooks says under the heading, "The Present Forest Conditions (1911)[5].

"**The Present Forest Conditions.**—In consequence of the limited lumber industry in the county most of the wooded area has remained to the present in a virgin state. Of 140,000 acres, approximately, of timberland, 138,000 acres are virgin and 2,000 are cut over. The virgin forests lie on the mountains in more or less continuous broad belts running from northeast to southwest, and in smaller boundaries scattered here and there. The cut-over forests are principally on the west of Spruce Mountain. The sawing of small mills has been on lands that were soon to be 'improved'. This accounts for the absence of cut-over forests in the central and eastern sections. In addition to the above-mentioned forest lands about 60 per cent. of the farm land is growing well-timbered woodlots.

[4]West Virginia Geological Survey, Volume V, p. 224; 1911.
[5]Idem, p. 226.

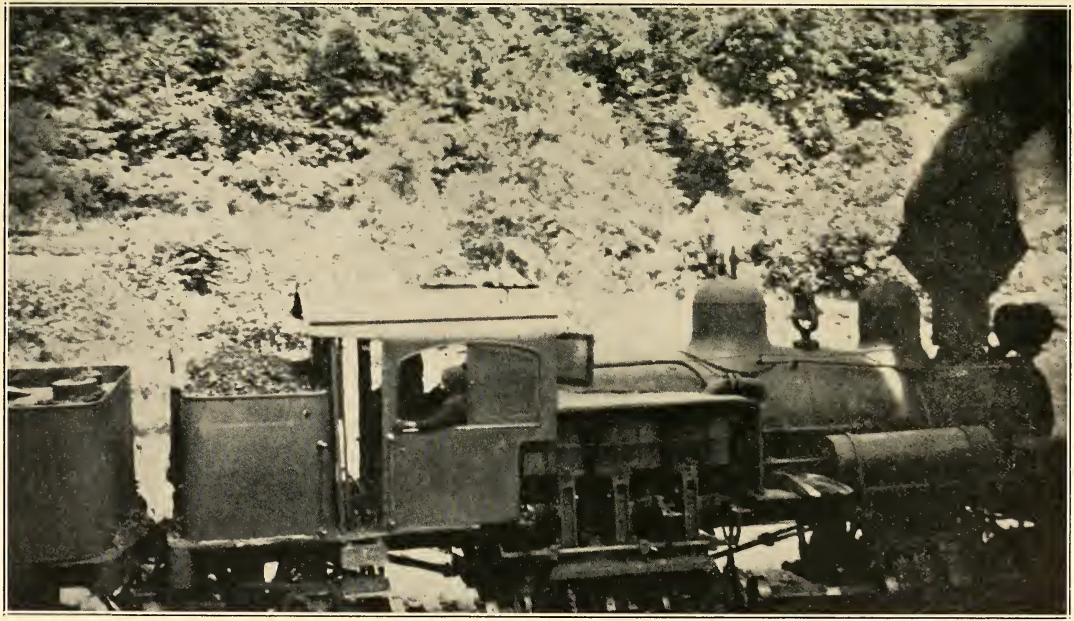

PLATE LXXX.—Lumber engine in use along the headwaters of Seneca Creek. (Photo. by John L. Tilton).

"As stated under another head, many of the mature pines were killed in 1891 and 1892 by insects. In some localities where this destruction occurred there is a good reproduction of young pines; but in most cases, especially where destruction of seed trees was complete, a young hardwood forest is growing up among the decaying pine logs. The appearance of hardwoods to succeed the conifers is not discouraging as the young trees are of valuable kinds. Locust, in particular, is abundant in places and is remarkably free from the enemies that disturb its growth in many other parts of the State.

"From many standpoints the conditions of most sections of the country are ideal. The rich valleys produce abundant yields of vegetables, fruits, and grains, and the forest-covered mountains insure a constant flow of clear and unpolluted water. Over a large area in the western part, however, conditions are somewhat reversed. As the result of a disastrous forest fire which originated 50 years ago from a camp of scouts on the Roaring Plains, it is said, and many subsequent fires, about 20,000 acres of mountain land are burned over."

Mr. Brooks lists[6] the following plants and animals as found in the Spruce Mountain area:

Red Spruce,	*Picea rubens.*
White Pine.	*Pinus strobus.*
Yellow Birch,	*Betula lutea.*
Mountain Ash.	*Sorbus americanum.*
Wild Red Cherry.	*Prunus pennsylvanica.*
Mountain Maple,	*Acer spicatum.*
June-berry (Shadbush)	*Amelanchier canadensis.*
Dotted Thorn,	*Crataegus punctata.*
Mountain Laurel,	*Kalmia latifolia.*
Alleghany menziesia.	*Menziesia pilosa.*
Black Huckleberry.	*Gaylussacia resinosa.*
Wintergreen,	*Gaultheria procumbens.*
Trailing Arbutus,	*Epigeae repens.*
Mountain Cranberry,	*Oxycoccus erythrocarpus.*
Wild Holly,	*Ilicoides mucronata.*
Mountain Holly.	*Ilex monticola.*
Black Chokeberry,	*Aronia nigra.*
Fetid Currant (Skunk-Currant),	*Ribes prostratum.*
Dwarf Cornel (Bunchberry),	*Cornus canadensis.*
Red Raspberry,	*Rubus strigosus.*
Wild Bleeding-Heart.	*Bicuculla eximia.*
Great Willow-Herb.	*Epilobium angustifolium.*
Painted Wake-Robin,	*Trillium undulatum.*
Canada May-Flower,	*Unifolium canadense.*
Yellow Clintonia.	*Clintonia borealis.*
Pink Moccasin-Flower,	*Cypripedium acaule.*
Round-Leaved Orchid,	*Lysias orbiculata.*
Bracken-Fern.	*Pteridium aquilinum.*
Cinnamon Fern,	*Osmunda cinnamomea.*
Polypody (Common Fern),	*Polypodium vulgare.*
Ground-Pine,	*Lycopodium obscurum.*
Running Pine.	*Lycopodium clavatum.*
Festoon Ground-Pine,	*Lycopodium complanatum.*

[6]Idem, p. 229.

"The list here given is far from complete but includes the majority of plants, from the club mosses up, which grew on the highest parts of Spruce Mountain. A thorough search would reveal many additional and interesting flowering plants and a large number of cryptogams. A list of the numerous plants which grow in the wooded portions of the mountains might be given, but for lack of space this is not included.

"The mammal and bird life of Spruce Mountain is no less interesting than the plant life; and the region is as definitely characterized as Canadian by the one as by the other. Some of the representatives of the mammalian fauna found upon or in the vicinity of the mountains are the Black Bear, *Ursus americanus*, the Raccoon, *Procyon lotor*, the Red Fox, *Vulpes fulvus*, the Bay Lynx, *Lynx rufa*, the Varying Hare, *Lepus americanus (campestris)*, and the Red Squirrel, *Sciurus hudsonicus*. Among the smaller mammals are the Smoky Shrew, *Sorex fumeus*, the Star-nosed Mole, *Condylura cristata*, Cooper's Lemming (Lemming-Mouse), *Synaptomys cooperi*, Red-backed Mouse, *Evotomys gapperi*, and the Canadian White-footed Mouse, *Peromyscus maniculatus nubiterrae*.

"The birds are represented by such species as the Veery (Thrush), *Hylocichla (Turdus) fuscescens*, the Olive-backed Thrush, *Hylocichla ustulata swainsonii*, the Golden-crowned Kinglet, *Regulus satrapa*, the Red-breasted Nuthatch, *Sitta canadensis*, the Winter Wren, *Nannus (Troglodytes) hiemalis*, the Magnolia Warbler, *Dendroeca maculosa*, the Canadian Warbler, *Wilsonia canadensis*, the Rose-breasted Grosbeak (Finch), *Zamelodia (Habia) ludoviciana*, the Barred Owl, *Strix varia*, and the Red-tailed Hawk, *Buteo borealis*."

Mr. Earl L. Core of the Department of Botany at West Virginia University, who is now (1927) engaged in a study of the plant relations on Spruce Knob, kindly furnishes the following with reference to that region:

"The rocky knob yields but few species of plants. Seedlings of red spruce *(Picea rubens)* occur in patches, their asymmetrical crowns demonstrating vividly the effect of the prevailing winds. In other places the ground is occupied with a heath association, occasionally so dense as to be almost impenetrable, few of the shrubs being higher than a man's head. Among the species represented are the following:

"*Menziesia pilosa* (Alleghany Menziesia)
Pyrus americana (Sorbus americanum) (Mountain Ash)
Ilex monticola (Mountain Holly)
Diervilla lonicera (Bush-Honeysuckle)
Amelanchier canadensis (Shadbush, June-berry)
Prunus pennsylvanica (Wild Red Cherry)
Acer pennsylvanicum (Striped Maple)
Rubus idaeus var. aculeatissimis (the Wild Red Raspberry)
Vaccinium erythrocarpum (Cranberry).

"With the above occur various other species of a similar type. An occasional red maple *(Acer rubrum)* or hemlock *(Tsuga canadensis)* is always greatly dwarfed and appears most unhappily located. Among herbaceous plants the following may be found:

"*Pteris aquilina* (Bracken Fern)
Lycopodium obscurum var. dendroideum (Ground Pine)
Lycopodium clavatum (Club Moss, Running Pine)
Trillium undulatum (Painted Wake-Robin)
Trillium erectum (Purple Trillium, Birthroot)
Cypripedium parviflorum (Small Lady's Slipper)
Carex tribuloides (var. Sedge)
Carex brunnescens (var. Sedge)
Epilobium angustifolium (Great Willow-Herb)
Cornus canadensis (Dwarf Cornel. Bunchberry)
Aralia hispida (Bristly Sarsaparilla).

"All of these species are with distinct northern range. Over the rocks sprawl vines of *Ribes prostratum* (Skunk-currant) and *Polygonum cilinode*, likewise boreal types. Certain lichens, especially species of *Cladonia* (including the Reindeer Moss, *Cladonia rangiferina)* and mosses such as *Polytrichum* are very common on the dry tableland.

"Just south of the Knob is found an open grassy meadow, free from rocks except for a few giant conglomerate boulders, where may be found plants of a somewhat ruderal nature, such as the following, and others:

"*Veronica serpyllifolia*	(Thyme-leaved Speedwell)
Rumex acetosella	(Horse-sorrel, Sheep-sorrel)
Oxalis corniculata	(Clover-sorrel)
Poa compressa	(Wire-Grass)
Potentilla monspeliensis	(Rough Cinquefoil)
Ranunculus abortivus	(Small-flowered Crowfoot)
Achillea millefolium	(Yarrow, Milfoil)
Taraxacum erythrospermum	(Red-seeded Dandelion)
Trifolium repens	(White Clover).

"Against the eastern mountain slope and in the deep ravine between the fire tower and the warden's house one finds a mesophytic forest, the aspect of which is strongly suggestive of the Canadian birch or spruce forests. In places spruce is dominant, the floor being covered with rotting spruce trunks on which are ranged the next generation, the spruce seedlings. *Oxalis acetosella* (common wood-sorrel) is perhaps dominant among the non-woody plants on such a floor. In other places birch is dominant and one finds such smaller plants as the following:

"*Viburnum alnifolium* (Hobble-bush)
Hamamelis virginiana (Witch-hazel)
Amelanchier canadensis (June-berry, Shadbush)
Polypodium vulgare (Common Polypody. Fern)
Osmunda claytoniana (Clayton's Flowering Fern)
Botrychium virginianum (Virginia Grape-fern).
Lycopodium lucidulum (Shining Club-Moss)
Festuca nutans (Fescue-grass)
Carex platyphylla (var. Sedge)
Streptopus roseus (Twisted-stalk Lily)
Allium tricoccum (Wild Leek, "Ramps")
Polygonatum biflorum (Salomonia biflora) (var. Solomon's-Seal)
Circaea alpina (Smaller Enchanter's Nightshade)
Impatiens biflora (Spotted Touch-me-not)
Maianthemum canadensis (var. False Solomon's-Seal)
Tiarella cordifolia (False Miterwort)
Cimicifuga racemosa (Rattleweed, Black Cohosh, Black Snakeroot)
Clintonia borealis (Clinton's Lily)
Laportea canadensis (var. Nettle)

Caulophyllum thalictroides (Blue Cohosh)
Actaea alba (White Baneberry)
Geranium maculatum (Wild Geranium)
Arisaema triphyllum (Jack-in-the-Pulpit)
Dentaria diphylla (Pepperroot, Two-leaved Toothwort)
Dioscorea villosa (Wild Yam-root, Colic-root)
Eupatorium purpureum (Joepye-weed, Trumpetweed)
Eupatorium urticaefolium (var. Thoroughwort, Boneset)
Saxifraga micranthidifolia (Lettuce Saxifrage)
Aconitum uncinatum (Wild Monk's-hood).

"Great areas of the ridge are covered with a growth of ferns *(Dicksonia punctilobula)* so dense as to exclude all other vegetation. The great extent of this fern is indicated by the fact that farmers of the region cut it by the acres and use it for hay. The wild bleeding-heart *(Dicentra eximia)* is common in similar habitats, reclining on boulders and fallen trunks of trees.

"Another most interesting plant of the moister nooks is *Veratrum viride*, the American hellebore, a sub-boreal plant which is a deadly poison for cattle and is much dreaded by stock-raisers. Its spire-like inflorescence and its large green leaves render it a plant readily noticed.

"In an occasional meadow on the ridge many grasses and flowering plants common to the lowlands occur. Among these are the following:

"*Phleum pratense* (Timothy)
Agrostis alba (White Bent-grass)
Sisyrinchium angustifolium (Blue-eyed grass)
Sisyrinchium gramineum (var. Blue-eyed Grass)
Potentilla canadensis (Five-Finger)
Trifolium pratense (Red clover)
Achillea millefolium (Yarrow, Milfoil)
Prunella (Brunella) vulgaris (Allheal)
Oenothera (Kneiffia) pumila (Small Sundrops)
Geum canadensis (White Avens)
Hypericum punctatum (var. St.-John's-wort)
Plantago rugelii (Common Plantain)
Phlox paniculata (Garden Phlox)
Lathyrus venosus (Veiny Pea)
Erigeron ramosus (Daisy-Fleabane)
Chrysanthemum leucanthemum (Ox-Daisy, "Sheriff Pink", Common Daisy)

"In moister spots:

"*Carex stipata* (var. Sedge)
Carex crinita (var. Sedge)
Mentha piperita (Peppermint).

"Such species as *Asclepias syriaea* (Milkweed) and *Phytolacca decandra* (Poke, Scoke, Garget), common enough in the valley 2800 feet below, are here quite noticeably absent.

"The western slope of the mountain is covered with a scraggly thicket of varying character, in places large, mostly dying, fire (wild red) cherry *(Prunus pennsylvanica)*, smaller mountain ash *(Pyrus americana)*, and mountain maple *(Acer spicatum)* with undergrowth of *Ribes rotundifolium* (Smooth Gooseberry) and *Dicksonia punctilobula* (ferns). In other places it becomes nearly solid red spruce *(Picea rubens)* with a more sparse undergrowth of *Dicksonia punctilobula* (hay-scented ferns) *Carex brunnescens* (sedge), *Maianthemum canadensis* (var. False Solomon's-Seal), *Trillium erectum* (Purple Trillium, Birthroot), *Trillium undulatum* (Painted Wake-Robin) and *Galium sp.* (Goose-grass)."

LIST OF COLLECTIONS AND ANALYSES.

(Only collections and analyses made for this Report are here listed).

Fossil Collections.

Number.	Formation.
4	Rondout.
5	Bossardville, Camarotoechia zone.
6	Bossardville, Hindella zone.
7	Rondout.
8	Selinsgrove Shale.
9	Bloomsburg.
10	Niagara Limestone.
11	Niagara Limestone.
12	Selinsgrove Limestone.
13	New Scotland.
14	Niagara.
15	Niagara.
16	Bossardville.
17	Genesee.
18	Genesee.
19	Hamilton.
20	Bossardville, Hindella zone.
21	Coeymans, bottom.
22	Coeymans.
23	Coeymans.
25	Clinton.
26	Clinton.
30A	Clinton Limestone.
30B	Clinton Limestone.
31A	Clinton Shale.
31B	Clinton Shale.
33	Genesee.
34	Hamilton.
35	Genesee.
36	Hamilton.
37A	Selinsgrove Limestone, lowest.
37B	Selinsgrove Limestone, middle, main limestone.
37C	Selinsgrove Limestone, top.
38	Selinsgrove Shale.
39	Genesee-Hamilton contact.
40	Hamilton Shale.
41	Niagara.
43	Selinsgrove Limestone.
44	Oriskany.
45	Hamilton.
46	Bossardville, lowest at kiln.
46	Bossardville, lowest west of kiln.
48	Bossardville, upper east of kiln.
49	Clinton.
50	Niagara.
51	Niagara.
52	Oriskany.
53	Clinton.
54	Portage.
55	Genesee, bottom.
56	Genesee, middle.
57	Genesee, top.

58	Genesee.
59	Genesee.
60	Hamilton.
61	Chemung.
62	Pocono.
63	Lillydale.
64	Glenray.
65	Reynolds.
66	Reynolds.
67	Reynolds.
68	Ada.

Igneous Rock.

1. T. L. 39, Lab. No. 3023.

Clinton Iron Ore.

7. T. L. 23, Lab. No. 2996.
8. T. L. 24, Lab. No. 2997.
9. T. L. 25, Lab. No. 2998.
10. P. H. 9, Lab. No. 2976.

Clinton Sandstone.

1. T. L. 5, Lab. No. 2965.

Oriskany Iron Ore.

6. T. L. 20, Lab. No. 2983.
7. T. L. 21, Lab. No. 2984.
8. T. L. 26, Lab. No. 2997.
9. T. L. 27, Lab. No. 3000.

Oriskany Sandstone.

1. T. L. 22, Lab. No. 2985.

Manganese.

10. T. L. 42, Lab. No. 3064.

Coal.

1. T. L. 19, Lab. No. 2982.
2. T. L. 18, Lab. No. 2981.

Limestone.

1. T. L. 39, Lab. No. 3007.
2. T. L. 30, Lab. No. 3008.
3. T. L. 2, Lab. No. 2961.
4. T. L. 31, Lab. No. 3009.
5. T. L. 1, Lab. No. 2960.
6. T. L. 22, Lab. No. 3010.
7. T. L. 33, Lab. No. 3011.
8. P. H. 7, Lab. No. 2974.
9. P. H. 14, Lab. No. 2990.
10. P. H. 12, Lab. No. 2988.
11. P. H. 15, Lab. No. 2991.
12. P. H. 13, Lab. No. 2989.
13. P. H. 10, Lab. No. 2977.
14. P. H. 8, Lab. No. 2975.
15. P. H. 11, Lab. No. 2987.
16. T. L. 4, Lab. No. 2964.
17. T. L. 34, Lab. No. 3012.
18. T. L. 3, Lab. No. 2963.
19. T. L. 35, Lab. No. 3014.
20. T. L. 37, Lab. No. 3015.

Limestone.

21. T. L. 36, Lab. No. 3013.
22. P. H. 17, Lab. No. 2986A.
23. T. L. 14, Lab. No. 2977.
24. T. L. 8, Lab. No. 2968.
25. T. L. 9, Lab. No. 2969.
26. T. L. 10, Lab. No. 2970.
27. T. L. 11, Lab. No. 2971.
28. T. L. 12, Lab. No. 2972.
29. T. L. 7, Lab. No. 2967.
30. T. L. 13, Lab. No. 2973.
31. T. L. 38, Lab. No. 2016.
32. T. L. 15, Lab. No. 2978.
33. T. L. 16, Lab. No. 2979.
34. T. L. 17, Lab. No. 2980.

APPENDIX.

LEVELS ABOVE MEAN TIDE.

By R. C. Tucker.

UNITED STATES GEOLOGICAL SURVEY LEVELS.

The various topographic quadrangles (Circleville, Fort Seybert, Horton, McDowell, Onego, Petersburg, and Spruce Knob) which make up the area of Pendleton County have been covered with a network of primary spirit-levels run by the United States Geological Survey. The quadrangles were surveyed in cooperation with the West Virginia Geological Survey. Map I is made up of portions of these sheets, and are also used as the base for Map II accompanying this Report. The elevations of the bench marks and other levels described in the following pages are shown in black on the maps mentioned.

The following descriptive remarks are quoted from Bulletin No. 632 of the United States Geological Survey, pages 5-7; 1916:

"**Classification.**—The elevations are classified as precise or primary, according to the methods employed in their determination. The former are determined by lines of levels run either in both forward and backward directions or by simultaneous double-rodded lines, a high-grade instrument being used and special precautions being taken in observations and reduction to correct errors and make the line continuously good throughout. The latter or primary levels are determined with the Y level, precautions being taken against only the principal errors and the levels being run mostly in circuits of single lines. The allowable limit of error observed on the precise work already done by the Geological Survey in this State is represented in feet by 0.02 times the square root of D, and that for the primary work by 0.05 times the square root of D, in which D is the length of the circuit in miles.

"**Bench Marks.**—The standard bench marks are of two forms. The first form is a circular bronze or aluminum tablet, 3½ inches in diameter and ¼ inch thick, having a 3-inch stem, which is cemented

in a drill hole in solid rock in the wall of some public building, a bridge abutment, or other substantial masonry structure. The second form, used where masonry or rock is not available, consists of a hollow wrought-iron post 3½ inches in outer diameter and 4 feet in length. The bottom is spread out to a width of 10 inches in order to give a firm bearing on the earth. A bronze or aluminum cap is riveted upon the top of the post which is set about 3 feet in the ground. A third style of bench mark, with abbreviated lettering, is used for unimportant points. This consists of a special copper nail 1½ inches in length driven through a copper washer ⅞ inch in diameter. The tablets as well as the caps on the iron posts are appropriately lettered, and cooperation by States is indicated by the addition of the State name.

"The numbers stamped on the bench marks described in the following pages represent the elevations to the nearest foot as determined by the levelman. These numbers are stamped with $\frac{3}{16}$-inch steel dies on the tablets or post caps, to the left of the word 'Feet'. The office adjustment of the notes and the reduction to mean sea-level datum may so change some of the figures that the original markings are 1 to 2 feet in error. It is assumed that engineers and others who have occasion to use the bench-mark elevations will apply to the Director of the United States Geological Survey, at Washington, D. C., for the adjusted values, and will use the markings as identification numbers only.

"**Datum.**—All elevations determined by the United States Geological Survey and United States Coast and Geodetic Survey are referred to mean sea-level, which is the level that the sea would assume if the influence of winds and tides were eliminated. This level is not the elevation determined from the mean of the highest and the lowest tides, nor is it the half sum of the mean of all the high tides and the mean of all the low tides, which is called the half-tide level. **Mean sea-level is the average height of the water, all stages of the tide being considered.** It is determined from observations made by means of tidal gages placed at stations where local conditions, such as long narrow bays, rivers, and like features, will not affect the height of the water. To obtain even approximately correct results these observations must extend over at least one lunar month, and if accuracy is desired they must extend over several years. At ocean stations the half-tide level and the mean sea-level usually differ but little. It is assumed that there is no difference between the mean sea-levels determined from observations in the Atlantic Ocean, the Gulf of Mexico, and the Pacific Ocean.

"The connection with tidal stations for bench marks in certain areas that lie at some distance from the seacoast is still uncertain, and this fact is indicated by the addition of a letter or word to the right of the word 'Datum' on tablets and posts. For such areas corrections for published results will be made from time to time as the precise-level lines of the United States Geological Survey, the United States Coast and Geodetic Survey, or other Government organizations are extended."

The descriptions given on the following pages were furnished by the Director of the United States Geological Survey and have not been published by that organization. The levels on some of the quadrangles, however, have been published in part by the West Virginia Geological Survey when some of

the same sheets were used in making up the maps for the adjoining areas of Grant, Tucker, and Hardy Counties to the north and northwest. The levels are given by quadrangles. Mileages mentioned in the descriptions of bench marks are road mileages and are not air-line distances from the towns and post-offices mentioned to the points where the levels were taken:

CIRCLEVILLE QUADRANGLE: PENDLETON COUNTY.

(Latitude 38° 30′-38° 45′; Longitude 79° 15′-79° 30′).

Along highways west, near north border of quadrangle. Leveled twice.

Leveling by Walter McCrea in 1919:

(Line jogs from Onego Quadrangle.)

	Feet.
Upper Tract, 5.0 miles southwest of, east of George Teter's dwelling, east side of ford, at Reeds Creek, in root of sycamore tree; copper nail and washer, "T. B. M. 1,832" painted on tree	1,829.84
Upper Tract, 6.0 miles southwest of, at intersection of roads to Riverton and Ruddle, east side of road, in large stump; copper nail and washer "T. B. M. 1,934" marked on stump	1,931.26
Upper Tract, 7.1 miles southwest of, 1.1 miles west of road forks, 5 feet west of road, in large flat rock; bronze tablet stamped "2,259 W. Va."	2,259.344

(Five bench marks omitted here are in Onego Quadrangle.)

Riverton, 0.80 mile northeast of, 25 feet north of Ellen Johnston's dwelling, 15 feet south of road, in large boulder; bronze tablet stamped "1,927 W. Va."	1,926.865
Riverton, intersection of roads, in front of Sylvanus Harper's dwelling, in small rock; chiseled square, "T. B. M. 1,785", painted on fence	1,782.22

Leveling by E. E. Harris in 1921:

From Riverton southwest along highway across northwest part of quadrangle to Circleville.

Riverton, intersection of roads, in front of Sylvanus Harper's dwelling, in small boulder; chiseled square, "T. B. M. 1,785", painted on fence	1,782.22
Riverton, 0.97 mile south of post-office, at **Harper Mill,** on edge of right-angle turn in road, 140 feet east of mill-race, in west root of 30-inch walnut tree; copper nail and washer, fence marked "U. S. 1,827.4 B. M."	1,827.35

Riverton, 1.98 miles south of post-office, on west edge of road, on south side of wooden culvert, in east root of

Feet.

oak tree 4.5 feet in diameter; copper nail and washer, tree marked "U. S. 1,914.4 B. M."..................... 1,914.42

Riverton, 2.38 miles south of post-office, 3.95 miles north of **Circleville**, 300 feet west of Briery Gap School, 30 feet north of road, 40 feet west of Briery Gap Run, in top of large flat boulder; bronze tablet stamped "1933 W. Va. 1921 H 67", fence marked "U. S. 1,933.3 B. M."......... 1,933.307

Witness bench mark, 45.5 feet S. 70° W. of tablet, on top of sandstone boulder; chiseled square.................... 1,930.97

Circleville, 2.83 miles north of, on north edge of road, 50 feet west of road forks, in west root of 20-inch willow tree; copper nail and washer, tree marked "U. S. 1,916.5 B. M." 1,916.48

Circleville, 1.88 miles north of, on south edge of road, 50 feet west of wooden culvert, on east side of lane through gate to pasture, on top of large outcrop of rock; chiseled square, gate-post marked "U. S. 2,008.2 B. M."........... 2,008.17

Circleville, 0.91 mile north of, on west edge of road, 60 feet south of gate, in east root of 15-inch walnut tree; copper nail and washer, tree marked "U. S. 2,011.9 B. M.".. 2,011.93

Circleville, highway bridge over North Fork of Potomac River, in north end of west wing-wall of bridge, in top face of large stone; chiseled square, bridge railing marked "U. S. 2,053.6 B. M."......................... 2,053.58

Water surface under above bridge......................... 2,035.1

Circleville, in southwest corner of crossroads opposite post-office, in northeast corner of yard to home owned and occupied by Robert Bennett, in top of outcrop of rock; bronze tablet stamped "W. Va. 1921 H 68 2054," telephone-pole marked "U. S. 2,053.9 B. M."................ 2,053.893

Witness bench mark, 29.4 feet N. 50° W. of tablet, on top of outcrop of rock; chiseled square...................... 2,055.59

From Onego Quadrangle southwest along highways through center of quadrangle to Cave Post-Office, thence southwest 2 miles and west into Spruce Knob Quadrangle.

Ruddle, 2.13 miles north of, on east edge of road, on top of large knot, 1 foot above ground, on west side of tree; copper nail and washer, tree blazed and marked "U. S. 1,489.8 B. M."...................................... 1,489.85

Ruddle, 1.20 miles north of, on east edge of road, west bank of river, in west root of oak tree, 4 feet in diameter; copper nail and washer, tree marked "U. S. 1,508.7 B. M.".. 1,508.75

Ruddle, 0.48 mile north of, on east edge of road, just north of large oak tree, on top of flat boulder; chiseled square, tree marked "U. S. 1,517.1 B. M."..................... 1,517.16

Ruddle Post-Office, center of road in front of.............. 1,529.1

Feet.

Ruddle Post-Office, 0.24 mile south of, 130 feet southeast of road forks, on west edge of road, just south of concrete bridge over Hammer Run, in center of top of small concrete culvert; bronze tablet stamped "1533 W. Va. 1921 H 72", fence marked "U. S. 1,533 B. M."................ 1,532.995

Witness bench mark, 103 feet S. 65° E. of tablet, in west root of 20-inch leaning oak tree; copper nail and washer.... 1,529.99

Ruddle, 1.23 miles south of, on east edge of road, in line with road east, in center of top coping stone of culvert; chiseled square, fence marked "U. S. 1,554.5 B. M.".... 1,554.55

Ruddle, 2.29 miles south of, on west edge of road, at top of hill, on top of flat boulder; chiseled square, fence marked "U. S. 1,626.5 B. M."......................... 1,626.56

Ruddle, 3.30 miles south of, 3.02 miles north of **Franklin,** on south side of road, just east of lane to barn, in center of large stone to retaining wall; bronze tablet stamped "W. Va. '1616' 1921 H 73", side of barn marked "U. S. 1,615.9 B. M.".. 1,615.949

Witness bench mark, 38.0 feet north 15° west of tablet, in south root of 30-inch oak tree; copper nail and washer.. 1,621.38

Franklin, 2.57 miles north of, on top face of southwest wing-wall of concrete culvert over run; chiseled square, marked "U. S. 1,618.7 B. M."......................... 1,618.75

Franklin, 1.88 miles north of, on west edge of road, on north edge of entrance lane to home of Philip Ruddle, on top of 1-foot drain-pipe; chiseled square, fence-post marked "U. S. 1,796.8 B. M."................................. 1,796.78

Franklin, 1.19 miles north of, 160 feet south of road forks, on top face at southeast corner of parapet wall of concrete culvert over; chiseled square, wall marked "U. S. 1,786.3 B. M.".. 1,786.34

Franklin, at north end of town, 0.43 mile north of court-house, in northeast corner of road forks, in southwest corner of lower stone step at entrance to home of Mrs. Maude Mallow; chiseled square, wall marked "U. S. 1,751.8 B. M.".. 1,751.78

Franklin, in southeast corner of court-house yard, in top of concrete post; bronze tablet stamped "1731 W. Va. 1921 H 74", telephone-pole marked "U. S. 1,730.7 B. M.".... 1,730.712

Witness bench mark, 27.5 feet south of tablet, in west root of 12-inch maple tree; copper nail and washer.......... 1,729.38

Franklin, 1.02 miles south of, on west edge of road, just north of lane east through gate, on top of rock ledge; chiseled square, ledge marked "U. S. 1,716.4 B. M.".... 1,716.42

Franklin, 2.02 miles south of, on west edge of road, north of ╥ road west (to **Oak Grove**), on top face at south end of west parapet wall of concrete culvert over Smith Creek; chiseled square, wall marked "U. S. 1,763.4 B. M.".. 1,763.43

	Feet.
Franklin, 2.75 miles southwest of, on west edge of road, in line with ╥ road east, (to **McCoys Mill**) in corner of pasture, in top of concrete post; bronze tablet stamped "1790 W. Va. 1921 H 75", fence-post marked U. S. 1,790.1 B. M."	1,790.069
Witness bench mark, 78.2 feet south 40° west of tablet, in east root of 12-inch oak tree; copper nail and washer	1,789.46
Franklin, 3.74 miles southwest of, on west edge of road, at foot of hill and on east bank of river, on top of large flat boulder; chiseled square, tree marked "U. S. 1,802.2 B. M."	1,802.16
Franklin, 4.75 miles southwest of, on west edge of road, 80 feet south of gate to pasture, on top of outcrop of rock; chiseled square, telephone-pole marked "U. S. 1,836.3 B. M."	1,836.23
Franklin, 5.70 miles southwest of, on north edge of road, about 900 feet east of lane to farmhouse, on top face of rock ledge; bronze tablet stamped "1858 W. Va. 1921 H 76"	1,858.056
Witness bench mark, 33.3 feet S. 50° W. of tablet, on top of boulder; chiseled square	1,856.68
Franklin, 6.65 miles southwest of, on north edge of road, just east of drain and sharp turn in road-bed, in south root of apple tree inside fence line; copper nail and washer, fence marked "U. S. 1,925.1 B. M."	1,925.07
Franklin, 7.49 miles southwest of, on west edge of road, at sharp turn in road-bed, on top of outcrop of rock; chiseled square, fence marked "U. S. 1,947.1 B. M."	1,947.07
Franklin, 8.30 miles southwest of, 2.28 miles northeast of **Cave Post-Office,** 40 feet east of road center, 100 feet south of road forks, 400 feet southwest of **Mt. Olive Church,** in top of boulder; bronze tablet stamped "2018 W. Va. 1921 H 77", fence marked "U. S. 2,018.3 B. M."	2,018.244
Witness bench mark, 50.5 feet south 15° west of tablet, in east root of twin walnut tree; copper nail and washer	2,017.43
Cave Post-Office, 1.73 miles northeast of, just west of **Judy Bridge,** 60 feet south of road, 30 feet east of ╥ road east, in north root of 22-inch oak tree; copper nail and washer, fence marked "U. S. 2,013.8 B. M."	2,013.77
Cave Post-Office, 1.04 miles northeast of, **(Cave School),** on west edge of road, on south edge of Hammer Run, in south root of 30-inch oak tree; copper nail and washer, tree marked "U. S. 2,044.4 B. M."	2,044.33
Cave Post-Office, 10 feet north of northeast corner of, inside fence line, 30 feet west of road center, in top of concrete post; bronze tablet stamped "2069 W. Va. 1921 H 78", fence marked "U. S. 2,069 B. M."	2,068.986
Witness bench mark, 68 feet south 10° east of tablet, in west root of 20-inch maple tree; copper nail and washer	2,068.99

Feet.

Cave Post-Office, 0.92 mile southwest of, on east edge of road, 50 feet south of deserted house, on top of boulder; chiseled square, fence-post marked "U. S. 2,109.4 B. M." 2,109.34

Cave Post-Office, 1.65 miles southwest of, at angle in road, on west edge of road, on top of boulder; chiseled square, fence marked "U. S. 2,227.8 B. M."...................... 2,227.77

Cave Post-Office, 2.26 miles southwest of, at forks of ╥ road northwest (at **Harper**), 70 feet north by 30 feet west of, in southeast corner of **Harper School** yard, in top of large boulder; bronze tablet stamped "2219 W. Va. 1921 H 79", telephone-pole marked "U. S. 2,219.1 B. M.".... 2,219.046

Witness bench mark, 17.3 feet north 45° east of tablet, in east root of 12-inch elm tree; copper nail and washer.. 2,220.02

Cave Post-Office, 2.26 miles southwest of, thence 0.93 mile northwest of (**Harper**), on west edge of road, north edge of East Dry Run, on top of large boulder; chiseled square, boulder marked "U. S. 2,407.7 B. M."........... 2,407.68

Cave Post-Office, 2.26 miles southwest of, thence 1.89 miles northwest of (**Harper**), on north edge of road, in south root of 20-inch chestnut oak tree; copper nail and washer, tree marked "U. S. 2,662.3 B. M."............. 2,662.20

From Fort Seybert Quadrangle southwest along highways across southeast part of quadrangle into McDowell Quadrangle.

Brandywine, 1.96 miles southwest of, on east side of road, South Fork (Moorefield) River bed during high water, on top of boulder; chiseled square, rock cairn erected just north of dead stump, marked "U. S. 1,614.6 B. M." 1,614.70

Brandywine, 2.72 miles southwest of, on east edge of road, at east end of small wooden culvert, on ledge of rock; chiseled square, ledge marked "U. S. 1,710.9 B. M."... 1,710.98

Brandywine, 3.19 miles southwest of, on north edge of road, 100 feet west of stream and cross lane, in southeast corner of small garden, in top of concrete post; (covered up, not found, 1924); bronze tablet stamped "W. Va. 1921 H 84", gate-post marked "U. S. 1,639.7 B. M."........... 1,639.805

Witness bench mark, 38.9 feet north 15° west of tablet, in west root of large stump; copper nail and washer.... 1,641.66

Brandywine, 3.77 miles southwest of, on west edge of road, at south end of large triangle formed by road forks, in south root of 12-inch walnut tree; copper nail and washer, tree marked "U. S. 1,690.5 B. M."............. 1,690.55

Brandywine, 4.55 miles southwest of, at sharp angle in road, on east edge of road, 30 feet south of stream crossing, on top of boulder; chiseled square, fence marked "U. S. 1,691.1 B. M.".. 1,691.17

Brandywine, 5.54 miles southwest of, 5.47 miles northeast of **Sugar Grove,** on west edge of road, just south of **Lone**

	Feet.
Poplar School, in south root of 30-inch maple tree; copper nail and washer, fenced marked "U. S. 1,708.3 B. M."	1,708.40
Sugar Grove, 4.25 miles northeast of, west side of road, in southeast corner of yard to home of C. R. Kiser, in top of concrete post; bronze tablet stamped "1775 W. Va. 1921 H 85", fence marked "U. S. 1,774.5 B. M."	1,774.557
Witness bench mark, 12.8 feet south 30° west of tablet, on top of small outcrop of rock; chiseled square	1,774.02
Sugar Grove, 3.54 miles northeast of, on west edge of road, at road forks, in east root of 25-inch elm tree; copper nail and washer, fence marked "U. S. 1,747.7 B. M."	1,747.72
Sugar Grove, 2.45 miles northeast of, on east edge of road, 40 feet west of **Brooklyn School**, in south root of 12-inch walnut tree; copper nail and washer, fenced marked "U. S. 1,793 B. M."	1,793.10
Sugar Grove, 1.44 miles northeast of, on west edge of road, and north edge of private lane west to farmhouse, in east root of 8-inch wild plum tree; copper nail and washer, corner fence-post marked "U. S. 1,816 B. M."	1,816.05
Sugar Grove, on south edge of road, 150 feet west of ╦ road south, in top of large boulder; bronze tablet stamped "1886 W. Va. 1921 H 86", boulder marked "U. S. 1,886.4 B. M."	1,886.458
Witness bench mark, 158.3 feet north 30° west of tablet, at southeast corner of shed, on top of large boulder; chiseled square	1,891.48
Sugar Grove, 0.71 mile south of, on south edge of road, 50 feet east of road forks, 20 feet east of gate, on top of boulder; chiseled square, fenced marked "U. S. 1,875.8 B. M."	1,875.78

From Judy Bridge southeast along highways in south part of quadrangle to Sugar Grove.

Cave Post-Office, 1.73 miles northeast of, just west of **Judy Bridge**, 60 feet south of road 30 feet east of ╦ road east, in north root of 22-inch oak tree; copper nail and washer, fence marked "U. S. 2,013.8 B. M."	2,013.77
Judy Bridge, (at **Moyer Gap**), over South Branch Potomac River, in south end of east bridge seat; chiseled square, bridge rail marked "U. S. 1,990.7 B. M."	1,990.73
Surface of water under above bridge, July 23, 1921	1,980.
Judy Bridge, 0.70 mile east of, on east edge of sharp turn in road, 30 feet north of small wooden bridge over run, on pointed boulder; chiseled square, boulder marked "U. S. 2,120.5 B. M."	2,120.48
Judy Bridge, 1.38 miles east of, in fork of Y road, in north	

Feet.

root of locust stump; copper nail and washer, shed marked "U. S. 2,321.9 B. M."........................... 2,321.78

Judy Bridge, 2.46 miles east of, 3.93 miles west of **Johnstown (Moyers P. O.),** 40 feet south of road, in gap, 40 feet west of road forks, in pasture field, in top of concrete post; bronze tablet stamped "2652 W. Va. 1921 H 87".. 2,652.065

Witness bench mark, 93 feet S. 80° W. of tablet, in north root of 15-inch locust tree; copper nail and washer.... 2,657.03

Johnstown (Moyers P. O.), 2.96 miles west of, 160 feet south of **Harper School,** on west edge of sharp turn in road, in west root of 20-inch oak tree; copper nail and washer, fence marked "U. S. 2,595.2 B. M."..................... 2,595.04

Johnstown (Moyers P. O.), 2.33 miles west of, on south edge of road, at mouth of **Caton Hollow,** on top of boulder; chiseled square, boulder marked "U. S. 2,426 B. M."... 2,425.86

Johnstown (Moyers P. O.), 1.38 miles west of, 40 feet west of north and south road, 100 feet north of ╥ road east, 70 feet east of southeast corner of **Sinnet School,** in top of boulder flush with ground; bronze tablet stamped "2278 W. Va. 1921 H 88", boulder marked "U. S. 2,277.6 B. M." 2,277.522

Witness bench mark, 42.4 feet south 10° east of tablet, on top of flat boulder; chiseled square................... 2,275.98

Johnstown (Moyers P. O.), 0.74 mile west of, in center of grass triangle formed by forks of ╥ road north, on top of boulder; chiseled square, upright support to foot-bridge over run marked "U. S. 2,167.7 B. M."......... 2,167.58

Johnstown (Moyers P. O.), 80 feet east of post-office, in northeast corner of ╥ road west, on top of boulder: chiseled square, sign-post marked "U. S. 2,213.6 B. M." 2,213.49

Johnstown (Moyers P. O.), 0.47 mile northeast of, on east edge of road, south edge of lane, through gate to farm-house, in west root of 15-inch pear tree; copper nail and washer, fence marked "U. S. 2,323.1 B. M."............ 2,322.92

Johnstown (Moyers P. O.), 1.34 miles northeast of, 2.47 miles northwest of **Sugar Grove,** at (north) south end of field, southwest of triangle formed by road forks in top of concrete post; bronze tablet stamped "2666 W. Va. 1921 H 89", fence marked "U. S. 2,666 B. M."................ 2,665.817

Witness bench mark, 55.3 feet north 15° west of tablet, in east root of 20-inch chestnut tree; copper nail and washer.. 2,660.22

Sugar Grove, 1.70 miles northwest of, on east edge of sharp turn in road, on top of large flat boulder; chiseled square, boulder marked "U. S. 2,377.7 B. M."......... 2,377.54

Sugar Grove, 0.94 mile west of, on south edge of road, 40 feet west of stream crossing, on top of boulder; chiseled square, boulder marked "U. S. 2,052.2 B. M."......... 2,052.02

From McDowell Quadrangle northeast along highways to Sinnet School.

Feet.

Sinnet School, 2.26 miles southwest of, on west edge of road, 50 feet north of bars to pasture, in east root of 30-inch oak tree; copper nail and washer, fence marked "U. S. 2,435.7 B. M."........ 2,435.42

Sinnet School, 1.87 miles southwest of, 40 feet east of road center, 30 feet south of lane east through gate to farmhouse of T. H. Propst, in top of concrete post; bronze tablet stamped "2399 W. Va. 1921 H 95"........ 2,398.748

Witness bench mark, 49.4 feet north 25° east of tablet, on top of boulder; chiseled square........ 2,395.57

Sinnet School, 1.25 miles southwest of, at forks of lane east, in northeast corner, in root of tree; copper nail and washer, marked "U. S. 2,306.1 B. M."........ 2,305.81

Sinnet School, 0.61 mile south of, on north edge of road between reverse curves in road, 10 feet west of gate, in south root of 6-inch oak tree; copper nail and washer, fence marked "U. S. 2,354.8 B. M."........ 2,354.58

FORT SEYBERT QUADRANGLE: PENDLETON COUNTY.

(Latitude 38° 30′-38° 45′; Longitude 79°-79° 15′).

Primary leveling by F. L. Shalibo in 1919:

From Petersburg Quadrangle along highways to Fort Seybert.

Kline, 3.6 miles southeast of, opposite ╥ road west, on east edge of road, in large boulder; bronze tablet stamped "W. Va. 2,541"........ 2,541.002

Kline, 4.3 miles southeast of, in center of triangle, at road forks, in root of 8-inch pine tree; copper nail, painted "2,611.2"........ 2,610.38

Fort Seybert, 4.1 miles west of, in locust tree, on north edge of road, at ╥ road north; copper nail, painted "2,690.3" 2,689.48

Fort Seybert, 3.1 miles west of, 0.25 mile south of **Egypt School,** 50 feet east of ╥ road south, on north edge of road, in large boulder; bronze tablet stamped "W. Va. 2,226"........ 2,226.473

Fort Seybert, 2.1 miles west of, on south edge of road, in large boulder; chiseled square, painted "2,053.0"........ 2,052.16

Fort Seybert, 1.0 mile north of, on point of spur, on north edge of road, in root of pine tree; copper nail, painted "1,907.8"........ 1,907.00

Fort Seybert, 300 feet north of store, 120 feet west of South Fork road, at north side of private garage, in large boulder; bronze tablet stamped "W. Va. 1,475"........ 1,475.251

Primary leveling by Walter McCrea in 1919:

From Petersburg Quadrangle along highways southwest to Fort Seybert.

Feet.

Wine Spring School, 5.5 miles south of, opposite Cyrus Ottinger's dwelling, east side of road, in small rock; chiseled square, "T. B. M. 1,538" painted on telephone-pole.. 1,536.94

Wine Spring School, 6.5 miles south of, 300 feet south of ╦ road west, opposite J. W. Trumbo's dwelling (0.1 mile north of **Pleasant Grove Church**), east side of road, in rock; bronze tablet stamped, "1,630 W. Va."........... 1,630.260

Wine Spring School, 7.5 miles south of, 10 feet east of road, in root of small oak tree; copper nail and washer, "T. B. M. 1,744" painted on tree......................... 1,743.04

Wine Spring School, 8.6 miles south of, 85 feet south of Charles Nesselrodt's dwelling, (0.1 mile north of **Bethlehem Church**), west side of road, on small pointed rock; chiseled square, painted "T. B. M. 1,610"............. 1,609.62

Wine Spring School, 9.4 miles south of, opposite M. T. Bower's dwelling, east side of road, in small rock; bronze tablet stamped "1,636 W. Va.".................. 1,636.387

Fort Seybert, 1.0 mile east of, west of road, (0.2 mile west of **New Bethel Church**); in root of large tree, copper nail and washer, "T. B. M. 1.490" painted on tree...... 1,488.98

Fort Seybert, 300 feet north of store, 120 feet west of South Fork road, on north side of private garage, in large boulder; bronze tablet stamped "1,475 W. Va."........ 1,475.251

From Peru along highways east to Virginia-West Virginia State line, thence southwest along same on ridge to point 3 miles south of Mt. Pleasant School, thence west to Lick Run.

Virginia and West Virginia State line, 3 miles west of, on Camp Run road, on north edge of road, in large boulder; bronze tablet stamped "W. Va. 1,746"................. 1,745.892

South Fork road, 1.1 miles east of, on Camp Run road, 10 feet east of gate to field road, in root of large tree; copper nail, painted "1,573.2"......................... 1,572.19

Primary leveling by E. E. Harris in 1921:

From Fort Seybert southwest along highways into Circleville Quadrangle.

Fort Seybert, 0.78 mile southwest of, 200 feet south of **Cowger Mill,** in northeast corner of crossroads, on top of boulder; chiseled square, fence marked "U. S. 1,453.8 B. M."... 1,453.81

Fort Seybert, 1.80 miles southwest of, 1.42 miles northeast of **Oak Flat,** on west edge of road, in east root of oak tree 4 feet in diameter; copper nail and washer, tree marked "U. S. 1,569.1 B. M."......................... 1,569.14

	Feet.
Oak Flat, 0.79 mile northeast of, on east edge of road, 40 feet north of bridge over small run, in west root of oak tree 4 feet in diameter; copper nail and washer, tree marked "U. S. 1,528.3 B. M."	1,528.40
Oak Flat, in (north) southwest corner of ╗╔ road west to Franklin, 15 feet north of barn, in top of concrete post; bronze tablet stamped "1528 W. Va. 1921 H 82", gate-post marked "U. S. 1,528.4 B. M."	1,528.493
Witness bench mark, 20.9 feet north 25° west of tablet	1,529.98
Oak Flat, 1.04 miles southwest of, on west edge of road, 200 feet south of forks of private lane east, in east root of 40-inch oak tree; copper nail and washer, tree marked "U. S. 1,563.3 B. M."	1,563.33
Oak Flat, 1.71 miles southwest of, 2.00 miles northeast of **Brandywine** on east edge of road, 40 feet north of wooden bridge over small run, in top of stump; copper nail and washer, fence marked "U. S. 1,545.2 B. M."	1,545.27
Brandywine, 0.93 mile northeast of, on south edge of road, 200 feet east of right-angle turn in road to south, in north root of oak tree inside fence line, 5 feet in diameter; copper nail and washer, fenced marked "U. S. 1,614.2 B. M."	1,614.21
Brandywine, 0.39 mile north of, on top of northwest wing-wall of concrete bridge over South Fork of Potomac River; chiseled square, parapet wall marked "U. S. 1,577.5"	1,577.55
Water surface under above bridge	1,565.
Brandywine, at northwest corner of post-office, in southwest corner of front yard to residence of Postmaster, in top of concrete post; bronze tablet stamped "1586 W. Va. 1921 H 83", fence-post marked "U. S. 1,586.3 B. M."	1,586.319
Witness bench mark, 47.6 feet S. 60° W. of tablet, on west edge of road, on top of boulder; chiseled square	1,586.40
Brandywine, 0.89 mile southwest of, on west edge of road, 30 feet north of private lane, in east root of 25-inch oak tree; copper nail and washer, fence marked "U. S. 1,592.5 B. M."	1,592.56

HORTON QUADRANGLE: PENDLETON, RANDOLPH, AND TUCKER COUNTIES.

(Latitude 38° 45′-39°; Longitude 79° 30′-79° 45′.)

Leveling by C. K. Alexander in 1907:

From Tunnel Station east and south along Western Maryland R. R. to Bemis.

Meadows, 0.2 mile west of station, 10 feet south of railroad crossing, in ledge of rock; aluminum tablet stamped "2205"	2,204.609
Bowden, 2.8 miles south of, near log house west of railroad; in top face of stone coping of culvert; aluminum tablet stamped "2311"	2,310.504

Feet.

Woodrow, in front of station; top of rail.................. 2,358.9

Montes, in southwest concrete bridge seat of iron bridge over Cheat River; aluminum tablet stamped "2420".... 2,419.570

Bemis, in top face, east side of north abutment of wooden trestle railroad bridge over Fishinghawk Creek; aluminum tablet stamped "2576"............................ 2,574.35

Leveling by Walter McCrea in 1919:

From east border of quadrangle near Harperton northwest along highways to Harman, thence north along Central West Virginia and Southern Railroad to Gladwin (Parsons Quadrangle.)

Bench marks stamped in 1924.

Harman, 1.4 miles east of, south side of road, in large rock; chiseled square, painted "T. B. M. 2,567".............. 2,564.84

Harman, in front of M. J. Roy's store, in concrete curbing; bronze tablet stamped "2,359 W. Va.".................. 2,359.288

Harman, 1 mile north of, 380 feet south of road crossing, east side of railroad, in large rock; chiseled square, painted "T. B. M. 2,310"............................ 2,307.27

Harman, 2.0 miles north of, north side of track, in telegraph-pole; railroad spike, "T. B. M. 2,265" painted on pole.. 2,262.88

Harman, 2.9 miles north of, 15 feet south of railroad track, in large boulder on bank of Dry Fork; bronze tablet stamped "2,220 W. Va."............................ 2,220.061

Harman, 3.9 miles north of, at road crossing, west side of railroad track, in flat rock; chiseled square, "T. B. M. 2,183" painted on telegraph-pole...................... 2,180.47

Red Creek Junction, north end of station platform, in large square post; copper nail and washer, painted "T. B. M. 2,164"... 2,161.86

Red Creek Junction, 1.2 miles north of, 45 feet west of J. White's freight house, south side of track, in large pointed boulder; bronze tablet stamped "2,119 W. Va.".. 2,119.344

Red Creek Junction, 2.2 miles north of, 500 feet east of foot-bridge, south side of railroad track; railroad spike, in telegraph-pole painted "T. B. M. 2,090"................. 2,087.58

Jenningston, 0.4 mile southwest of station, north side of track, in ledge of rocks; chiseled square, "T. B. M. 2,061" painted on ledge.............................. 2,058.27

Jenningston, 1,400 feet northeast of station, 50 feet south of railroad track, northeast corner of locomotive barn, in large flat rock; bronze tablet stamped "2,035 W. Va.".. 2,034.730

	Feet.
Jenningston, 1.2 miles north of, 400 feet west of cabin, north side of track; railroad spike in telegraph-pole, painted "T. B. M. 1,996"	1,993.83
Gladwin, at north side of west end of wooden railroad bridge spanning Dry Fork, in large sandstone ledge; aluminum tablet stamped "1,943"	1,943.365

From Red Creek Junction east along highway into Onego Quadrangle.

Red Creek Junction, 0.8 mile southeast of, at intersection of roads, northeast end of culvert, in flat stone; chiseled square, painted "T. B. M. 2,236"	2,233.21

Primary leveling by E. E. Harris in 1924:

From Harman south along Central West Virginia and Southern Railroad and Horton Lumber Railroad to near south border of quadrangle, thence southwest along highways into Spruce Knob Quadrangle.

Harman, 1 mile north of, 380 feet south of road crossing, east side of railroad, 270 feet north of mill, in large rock; chiseled square, painted "T. B. M. 2,310"	2,307.27
Harman, in front of M. J. Roy's store, in concrete curbing; bronze tablet stamped "W. Va. 2,359"	2,359.288
Harman, 0.95 mile south of, 10 feet north of track, 230 feet east of lane crossing, 350 feet west of mile-post 9, on top of large boulder; chiseled square, telegraph-pole marked "U. S. 2,367.5 B. M"	2,367.57
Harman, 2.08 miles south of, 10 feet east of track, on south edge of lane to farmhouse, 1,400 feet north of road crossing, on top of boulder; chiseled square, telegraph-pole marked "U. S. 2,426.5 B. M."	2,426.52
Hazelwood (flag station), in front of station-sign; top of nearest rail, tie marked "U. S. 2,459.1"	2,459.2
Harman, 3.06 miles south of, 2.32 miles north of **Job**, 10 feet west of track, in top of large boulder; bronze tablet stamped "2472 W. Va. 1921 H 97"	2,472.461
Witness bench mark, 29.1 feet south 15° west of tablet, on top of boulder; chiseled square	2,475.83
Harman, 4.14 miles south of, 1.24 miles north of **Job**, in southwest corner of railroad trestle, in sill between rails; copper nail and washer, telegraph-pole marked "U. S. 2,518.9 B. M."	2,519.00
Job, 0.17 mile north of, 15 feet west of track, 40 feet south of garden fence, in top of pine stump; copper nail and washer, telegraph-pole marked "U. S. 2,574.6 B. M."	2,574.69
Job, in front of station; top of rail, marked on tie "U. S. 2,580.1"	2,580.2

	Feet.
Job, 0.71 mile south of, on west side of track, at switch, top of railroad spike, in switch, marked "U. S. 2,600.4 B. M."	2,600.52
Job, 1.12 miles south of, 3.44 miles northwest of **Whitmer,** 75 feet east of track, on south side of drain, in top of boulder; bronze tablet stamped "2623 W. Va. 1921 H 98", fence marked "U. S. 2,622.8 B. M."....................	2,622,872
Witness bench mark, 19.3 feet south 50° east of tablet, in west root of 15-inch walnut tree; copper nail and washer..	2,622.07
Whitmer, 2.44 miles northwest of, in southeast corner of railroad trestle over Dry Fork, in top of cross beam support to; copper nail and washer, guard-rail marked "U. S. 2,651.2 B. M."..................................	2,651.23
Gandy Station (flag stop), in front of station-sign; top of rail, "2,681.8" marked on telegraph-pole................	2,681.9
Whitmer, 1.46 miles northwest of, 0.24 mile south of **Gandy Station,** east of track, in southeast corner of steel highway bridge over Gandy Creek, in center of concrete bridge seat to; chiseled square, steel support marked "U. S. 2,693.3 B. M."..................................	2,693.47
Whitmer, 0.74 mile northwest of, east side of track, top of iron bolt at target-switch, painted white. fence marked "U. S. 2,733.9 B. M."..................................	2,734.04
Whitmer, in front of station; top of nearest rail of main-line track, marked "U. S. 2,759"........................	2,759.1
Whitmer, 0.32 mile south of station, 0.29 mile northwest of **Horton,** 50 feet west of track, 15 feet south of large sycamore tree, in top of large flat boulder; bronze tablet stamped "2780 W. Va. 1921 H 99", rock cliff marked "U. S. 2,780 B. M."..................................	2,780.143
Witness bench mark, 16 feet north 20° west of tablet, on top of boulder; chiseled square............................	2,780.96
Horton, in front of station; top of nearest rail, "U. S. 2,798.6" marked on front face of station platform..............	2.798.75
Horton, 0.65 mile south of, 700 feet north of **Keeter School (Little Italy),** west side of track, top of railroad spike in target-switch, painted white, "U. S. 2,840.7 B. M." marked on fence....................................	2,840.81
Horton, 1.63 miles south of, at southeast corner of railroad trestle over Gandy Creek, in top face of 8-inch by 8-inch cross beam support to; copper nail and washer, guard-rail marked "U. S. 2,896.2 B. M."....................	2,896.35
Horton, 2.60 miles south of, west side of track, east bank of Gandy Creek, in northeast corner of large boulder; chiseled square, boulder marked "U. S. 2,960.4 B. M."..	2,960.60
Horton, 3.55 miles south of, 14.7 feet east of track, 670 feet north of railroad trestle over Gandy Creek, in top face of ledge of rock; bronze tablet stamped "3021 W. Va. 1921 H 100", rock marked "U. S. 3,020.4 B. M."...............	3,020.609

	Feet.
Witness bench mark, 39.6 feet south of tablet, on top of boulder, chiseled square	3,017.73
Horton, 4.58 miles south of, east side of track, (0.7 mile northeast of **White**) on top of large pointed boulder; chiseled square, boulder marked "U. S. 3,082.3 B. M."	3,082.52
Horton, 5.70 miles south of, 20 feet east of track, in north root of large stump; copper nail and washer, stump marked "U. S. 3,145.6 B. M."	3,145.81
Horton, 6.36 miles south of, 10 feet east of track, 25 feet south of water-tank, in top face of ledge of rock; bronze tablet stamped "3187 W. Va. 1921 H 101", rock marked "U. S. 3,187.2 B. M."	3,187.346
Witness bench mark, 25.3 feet south 15° east of tablet, on top of large boulder; chiseled square	3,186.88
Horton, 7.19 miles south of, at north end of railroad trestle, in top face of sill between tracks; copper nail and washer, guard-rail marked "U. S. 3,225.3 B. M."	3,225.55

From Job west along highways to Bowden, thence south along railroad to Flint.

Job, 0.17 mile north of, 15 feet west of track, 40 feet south of garden fence, in top of pine stump; copper nail and washer, telephone-pole marked "U. S. 2,574.6 B. M."	2,574.69
Job, 0.56 mile west of, on south edge of road, in sharp turn in road, on east side of stream crossing, on top of boulder; chiseled square, telephone-pole marked "U. S. 2,817.2 B. M."	2,817.28
Job, 1.26 miles west of, on east edge of road, top of boulder; chiseled square, boulder marked "U. S. 3,167.1 B. M."	3,167.21
Job, 1.74 miles west of, 50 feet south of road, in gap, in east root of 18-inch elm tree; copper nail and washer, tree marked "U. S. 3,407.4 B. M."	3,407.49
Job, 2.34 miles west of, 1.1 miles southeast of **Wymer,** 30 feet south of road center, 50 feet east of second-class road south through gate, in top of large sandstone boulder; bronze tablet stamped "3125 W. Va. 1921 H 107"	3,124.944
Witness bench mark, 74.4 feet north 80° west of tablet, in south root of 15-inch beech tree; copper nail and washer	3,117.67
Wymer, 0.13 mile east of, at concrete highway bridge over Laurel Fork, in south end of east abutment to; chiseled square, rail marked "U. S. 2,787.5 B. M."	2,787.55
Wymer, in front of post-office; center of road	2,833.4
Wymer, 0.90 mile west of, on north edge of right-angle turn in road, on top of 15-inch galvanized iron drain-pipe; chiseled square, fence-post marked "U. S. 3,069.7 B. M."	3,069.74
Wymer, 1.31 miles west of, 2.43 miles east of **Evenwood,** in low gap, 150 feet north of crossroads, in top of small	

Feet.

boulder in pasture; bronze tablet stamped "3237 W. Va. 1921 H 108", telephone-pole marked "U. S. 3,236.9 B. M." 3,236.973

Witness bench mark, 48.9 feet south 35° west of tablet, in root of small tree; copper nail and washer............ 3,232.22

Evenwood, 1.59 miles east of, 150 feet west of **Flannigan School,** on south edge of road, in north root of large stump; corner nail and washer, stump marked "U. S. 2,893.2 B. M.".. 2,893.30

Evenwood, 0.60 mile east of, on north edge of road, on top face of large ledge of rock; chiseled square, ledge marked "U. S. 2,791.9 B. M."......................... 2,791.97

Evenwood, in north end of east bridge seat of new highway bridge over Glady Fork; chiseled square, marked "2,627.2".. 2,627.29

Evenwood, in north end of west bridge seat of new highway bridge over Glady Fork; chiseled square, marked "U. S. 2,627 B. M."... 2,627.04

Witness bench mark, 54.6 feet south 20° west of tablet, in east root of 10-inch elm tree; copper nail and washer.. 2,633.67

Evenwood, 0.69 mile north of, 0.58 mile south of **Alpena,** on east edge of road, 30 feet north of gate to pasture, at north end of triangle formed by road forks, in top of rock ledge; bronze tablet stamped "W. Va. 1921 H 109", (destroyed); fence-post marked "U. S. 2,829 B. M."..... 2,829.020

Alpena, in northwest corner of road forks, 80 feet north of post-office, in west root of 18-inch maple tree; copper nail and washer, telephone-pole marked "U. S. 2,718.1 B. M.".. 2,718.20

Alpena, 0.86 mile west of, on south edge of road, 250 feet west of dwelling, on top of boulder; chiseled square, fence-post marked "U. S. 2,917 B. M.".................. 2,917.07

Alpena, 1.67 miles west of, on west edge of road, on top of large pointed boulder; chiseled square, boulder marked "U. S. 2,820.3 B. M."................................ 2,820.35

Witness bench mark, 15.9 feet north 60° east of tablet, on top of large boulder; chiseled square.................. 2,847.11

Alpena, 2.42 miles west of, 2.88 miles east of **Bowden,** on west edge of road and south edge of lane west through gate, in top of boulder; bronze tablet stamped "2444 W. Va. 1921 H 100", gate-post "U. S. 2,443.6 B. M."........ 2,443.681

Bowden, 0.91 mile east of, 25 feet west of road center, inside fence line, 40 feet north of forks of lane, on top of pointed boulder; chiseled square, fence-post marked "2,251.2 B. M."...................................... 2,251.29

Bowden, 0.55 mile southeast of, on west side of track, W. M. R. R., on top of large boulder; chiseled square, boulder marked "U. S. 2,230 B. M."........................... 2,230.09

	Feet.
Bowden, 250 feet east of station, 40 feet south of track, on high bank, set in top of large sandstone boulder; bronze tablet stamped "2226 W. Va. 1921 H", boulder marked "U. S. 2,225.9 B. M."	2,225.959
Witness bench mark, 19.3 feet north 70° east of tablet, on top of boulder; chiseled square	2,228.13

(Old P. B. M. at Bowden destroyed in railroad improvements.)

Bowden, 1.47 miles south of, 25 feet east of track, on top of large boulder; chiseled square, rock cliff marked "U. S. 2,255.3 B. M."	2,255.36
Bowden, 2.21 miles south of, 0.70 mile north of **Weese**, 15 feet west of track, on top of boulder; chiseled square, boulder marked "U. S. 2,285.2 B. M."	2,285.24
Weese, 31 feet north of north end of station platform, west side of track, in center of stone coping of culvert; bronze tablet stamped "2311 W. Va. 1921 H", culvert marked "U. S. 2,311 B. M."	2,311.327
Witness bench mark, 31 feet south of tablet, in top of post, at northeast end of station platform; copper nail and washer	2,313.44
Weese, 1.09 miles south of, 0.40 mile north of **Woodrow**, west side of track, top of ledge of rock; chiseled square, ledge marked "U. S. 2,345 B. M."	2,345.01
Woodrow, in front of station-sign; top of nearest rail of main-line track	2,348.2
Woodrow, 0.71 mile north of, 0.43 mile north of **Flint**, at northwest corner of railroad trestle over run, top of iron bolt, painted white, guard-rail marked "U. S. 2,378.2 B. M."	2,378.25
Flint, in front of station-sign; top of nearest rail of main-line track	2,408.4
Flint, 0.6 mile south of, in south end of west concrete bridge seat of railroad bridge over Shavers Fork at **Montes** (bridge now abandoned); aluminum tablet stamped "W. Va. 2,420" (Bull. 632, p. 24)	2,419.570

From Evenwood northeast along highways (formerly lumber railroad) to Gladwin, Parsons Quadrangle.

Evenwood, 1.11 miles northeast of, east side of track, on top of boulder; chiseled square, boulder marked "U. S. 2,598.4 B. M."	2,598.48
Evenwood, 2.13 miles northeast of, south side of track, on top of boulder; chiseled square, boulder marked "U. S. 2,570.9 B. M."	2,571.02

	Feet.
Evenwood, 2.63 miles northeast of, 8 feet west of track, in top face of ledge of rock flush with ground; bronze tablet stamped "2553 W. Va. 1921 H 111", rock cliff marked "U. S. 2,553.3 B. M."	2,553.337
Witness bench mark, 44.5 feet north 30° east of tablet, on top of ledge of rock; chiseled square	2,555.48
Evenwood, 3.57 miles northeast of, north side of track, 20 feet east of target-switch, in west root of large stump; copper nail and washer, stump marked "U. S. 2,529.5 B. M."	2,529.57
Evenwood, 4.44 miles northeast of, south side of track, in north root of large stump; copper nail and washer, stump marked "U. S. 2,495 B. M."	2,495.08
Evenwood, 5.32 miles northeast of, south side of track, just east of drain, on top face of large ledge of rock; chiseled square, rock marked "U. S. 2,468.4 B. M."	2,468.53
Evenwood, 6.24 miles northeast of, 300 feet west of dwelling, south side of track, in top face of large boulder; bronze tablet stamped "2421 W. Va. 1921 H 112", boulder marked "U. S. 2,420.6 B. M."	2,420.700
Witness bench mark, 57.7 feet north 40° east of tablet, in east root of large stump; copper nail and washer	2,419.12
Evenwood, 7.24 miles northeast of, east of track, in top face of ledge of rock; chiseled square, rock marked "U. S. 2,369.8 B. M."	2,369.91
Evenwood, 8.32 miles northeast of, 0.25 mile northwest of water-tank, at east end of railroad trestle, in end of stringer between rails; copper nail and washer, guard-rail marked "U. S. 2,321.2 B. M."	2,321.34
Evenwood, 9.21 miles northeast of, east side of track, in north root of large stump; copper nail and washer, stamped marked "U. S. 2,283.6 B. M."	2,283.74
Evenwood, 9.91 miles northeast of, 7.20 miles southwest of **Gladwin**, 15 feet west of track, in top face of ledge of rock; bronze tablet stamped "2260 W. Va. 1921 H 113", rock marked "U. S. 2,260 B. M."	2,260.165
Witness bench mark, 116.8 feet east of tablet, on top boulder; chiseled square	2,258.69
Gladwin, 6.17 miles southwest of, north side of track, on top face of ledge of rock; chiseled square, rock marked "U. S. 2,219 B. M."	2,219.17
Gladwin, 5.15 miles southwest of, north side of track, on top face of ledge of rock; chiseled square, telegraph-pole marked "U. S. 2,185.5 B. M."	2,185.72
Gladwin, 4.61 miles southwest of, north side of track, at east end of cliff, on top face of ledge of rock; chiseled square, rock marked "U. S. 2,176.6 B. M."	2,171.81

Feet.

Gladwin, 3.74 miles southwest of, west side of track, in top face of ledge of rock, 3 feet above track; bronze tablet stamped "2137 W. Va. 1921 H 114", rock cliff marked "U. S. 2,136.9 B. M."............................ 2,137.039

Witness bench mark, 51.5 feet north 70° west of tablet, at base of cliff; chiseled square........................ 2,135.26

Gladwin, 2.99 miles southwest of, at northwest corner of railroad trestle over Glady Creek, in end of stringer between rails; copper nail and washer, guard-rail marked "U. S. 2,102.6 B. M.".. 2,102.77

Gladwin, 2.06 miles southwest of, west side of track, on top of long pointed boulder; chiseled square, boulder marked "U. S. 2,052.5 B. M."............................ 2,052.68

Gladwin, 1.04 miles southwest of, west side of track, on top face of ledge of rock; chiseled square, rock marked "U. S. 1,999.6 B. M."............................ 1,999.76

From point 5 miles northwest of Osceola, Spruce Knob Quadrangle, northwest along highways to Bemis.

Osceola, 6.41 miles northwest of, 4.91 miles southeast of **Glady, top of Middle Mountain**, 15 feet east of road, in gap, in west root of 15-inch hickory tree; copper nail and washer, tree marked "U. S. 3,680.8 B. M.".......... 3,681.07

Glady, 3.79 miles southeast of, on east edge of road, 60 feet south of trail up hollow, on top of small boulder, in angle of road; chiseled square, tree marked "U. S. 3,400.1 B. M.".. 3,400.37

Glady, 3.20 miles southeast of, 25 feet north of road center, 35 feet east of run crossing road, in top of large boulder; bronze tablet stamped "3129 W. Va. 1921 H 105", boulder marked "U. S. 3,128.8 B. M."........................ 3,129.086

Witness bench mark, 36.9 feet south 80° west of tablet, in south root of 30-inch elm tree; copper nail and washer.. 3,125.81

Glady, 2.21 miles southeast of, 50 feet north of road, 60 feet west of East Fork of Glady Creek, 200 feet east of crossing of log railroad and dirt road, in root of large stump; copper nail and washer, stump marked "U. S. 2,924.3 B. M.".. 2,924.56

Glady, 1.21 miles southeast of, 10 feet west of track, 50 feet south of second-class road crossing, in east root of large stump; copper nail and washer, stump marked "U. S. 2,876.4 B. M.".. 2,876.67

Glady, 0.59 mile southeast of, at railroad trestle over East Fork of Glady Creek in end of stringer between rails; copper nail and washer, guard-rail marked "U. S. 2,854.4 B. M.".. 2,854.67

	Feet.
Glady, 0.50 mile north of railroad station, 200 feet west of **Glady School**, on high bank, 80 feet west of Glady-Evenwood road, 20 feet north of Glady-Bemis road, in top of large boulder; bronze tablet stamped "2874 W. Va. 1921 H 106", fence-post marked "U. S. 2,874.1 B. M."........	2,874.452
Witness bench mark, 36.3 feet north 20° east of tablet, on top of large boulder; chiseled square..................	2,880.19
Glady, 0.91 mile west of, 1.19 miles east of **Bemis**, in northeast corner of road forks, on top of ledge of rock; chiseled square, rock marked "U. S. 2,883.7 B. M."........	2,884.06
Bemis, 0.44 mile east of, at new concrete highway bridge over Cheat River, on top of north end of west abutment to; chiseled square, marked "U. S. 2,587.7 B. M."......	2,588.08
Bemis, in front of station; top of nearest rail..............	2,586.6
Bemis, in top face, east side of north abutment of wooden trestle railroad bridge over Fishinghawk Creek; aluminum tablet stamped "2,574"...........................	2,574.350

From Glady southwest along Western Maryland Railroad into Elkins Quadrangle near its southeast corner.

Glady, 0.50 mile north of Western Maryland Railroad station, 200 feet west of **Glady School**, 80 feet west of Glady-Evenwood road, 20 feet north of Glady-Bemis road, 6 feet north of fence line, in top of large boulder, on high bank; bronze tablet stamped "2874 W. Va. 1921 H 106"	2,874.452
Witness bench mark, 36.3 feet north 20° east of tablet, on top of large boulder; chiseled square.................	2,880.19
Glady, in front of station; top of nearest rail, "2,913.3" marked on tie...	2,913.6
Glady, 0.54 mile southwest of, west side of track, in end of cross-beam of target-switch; top of iron spike, painted white, fence marked "U. S. 2,942 B. M."................	2,942.30
Glady, 1.54 miles southwest of, 30 feet northwest of track, on highest point of large outcrop of rock; chiseled square, rock marked "U. S. 2,993.2 B. M.".....................	2,993.49
Glady, 2.58 miles southwest of, 0.86 mile northeast of **Beulah**, 42 feet west of track, in large sandstone boulder; bronze tablet stamped "3035 W. Va. 1921 H 115", boulder marked "U. S. 3,034.5 B. M.".........................	3,034.850
Witness bench mark, 38 feet south 25° west of tablet, on top of boulder; chiseled square............................	3,041.43

McDOWELL QUADRANGLE: PENDLETON COUNTY.

(Latitude 38° 15'-38° 30'; Longitude 79° 15'-79° 30').

Leveling by E. E. Harris in 1921:

Stamped in 1924.

From Circleville Quadrangle along highways southwest to Palo Alto, Virginia, thence northwest to near Lone Oak School, thence north into Circleville Quadrangle.

	Feet.
Sugar Grove, 1.61 miles south of, on east edge of road, 30 feet south of road east across river, in west root of 30-inch sycamore tree; copper nail and washer, fence marked "U. S. 1,897 B. M."	1,896.89
Sugar Grove, 2.30 miles south of, in Y forks of road, on top of pointed boulder; chiseled square, fenced marked "U. S. 1,919.3 B. M."	1,919.27
Sugar Grove, 2.84 miles south of, on east edge of road, 650 feet southwest of road forks, 50 feet south of foot-bridge, 800 feet north of **Wilfong Church**, in top of large boulder; bronze tablet stamped "1938 W. Va. 1921 H 90", fence marked "U. S. 1,937.8 B. M."	1,937.722
Witness bench mark, 50.7 feet S. 75° W. of tablet, in west root of 15-inch walnut tree; copper nail and washer	1,939.83
Sugar Grove, 3.87 miles south of, 3.68 miles north of **Palo Alto, Virginia**, on west edge of road, 50 feet north of gate to pasture, in west root of 12-inch walnut tree; copper nail and washer, fence marked "U. S. 1,975.5 B. M."	1,975.37
Palo Alto, Virginia, 3.09 miles north of, in West Virginia, on west edge of road, 20 feet south of road west, in north root of stump; copper nail and washer, fence marked "U. S. 1,999.9 B. M."	1,999.84
Palo Alto, Virginia, 2.18 miles north of, in West Virginia, on east edge of road, at west end of foot-bridge over river, 80 feet north of ford, in west root of 30-inch sycamore tree; copper nail and washer, fence marked "U. S. 2,032.5 B. M."	2,032.37
Palo Alto, Virginia, 1.13 miles north of, in West Virginia, 30 feet east of road center, 30 feet north of small run crossing road opposite house, in top of concrete post; bronze tablet stamped "2077 W. Va. 1921 H 91", fence marked "U. S. 2,077.2 B. M."	2,077.063
Witness bench mark, 47.4 feet N. 70° W. of tablet, on top of boulder; chiseled square	2,080.29
Palo Alto, Virginia, 0.61 mile north of, in West Virginia, on east edge of road, 50 feet south of lane crossing river, in west root of 25 inch oak tree; copper nail and washer, fence marked "U. S. 2,105.8 B. M."	2,105.70

Feet.

Palo Alto, Virginia, 1.67 miles northwest of, in West Virginia, on west edge of road, 5 feet south of gate to farmhouse of W. P. Simmons, in top of large sandstone boulder; bronze tablet stamped "2507 W. Va. 1921 H 92", boulder marked "U. S. 2,506.7 B. M.".................. 2,506.544

Witness bench mark, 61.3 feet north of tablet, on top of large boulder; chiseled square........................ 2,511.62

Palo Alto, Virginia, 2.23 miles northwest of, in West Virginia, on west edge of road, in gap, 50 feet south of road forks, in east root of 30-inch chestnut tree; copper nail and washer, boulder marked "U. S. 2,830.4 B. M."...... 2,830.18

Palo Alto, Virginia, 3.12 miles northwest of, in West Virginia, on south edge of road, at northeast corner of barn, on top of boulder; chiseled square, barn marked "U. S. 2,585.5 B. M.".. 2,585.28

Palo Alto, Virginia, 4.07 miles northwest of, in West Virginia, on east edge of Doe Hill-Johnstown road, 30 feet north of ╥ road east to Palo Alto, about 0.25 mile south of **Lone Oak School,** in top of boulder; bronze tablet stamped "2432 W. Va. 1921 H 93", fence marked "U. S. 2,432 B. M.".. 2,431.821

Witness bench mark, 53.1 feet south 20° west of tablet, on top of boulder, in field; chiseled square................ 2,432.74

Palo Alto, Virginia, 4.93 miles northwest of, in West Virginia, on north edge of road, on east edge of lane north through gate, on top of small boulder; chiseled square, gate marked "U. S. 2,663.5 B. M."...................... 2,663.28

Palo Alto, Virginia, 5.58 miles northwest of, in West Virginia, on east edge of road, 20 feet north of Blackthorn Creek, at north end of foot-bridge, in south root of 6-inch maple tree; copper nail and washer, fence marked "U. S. 2,559.7 B. M.".. 2,559.46

Witness bench mark, 38.6 feet west of tablet, in east root of 40-inch oak tree; copper nail and washer.............. 2,738.74

Palo Alto, Virginia, 6.66 miles northwest of, in West Virginia, 4.92 miles south of **Sinnet School,** 40 feet east of road center, 150 feet north of forks of Y road, in top of concrete post; bronze tablet stamped "2737 W. Va. 1921 H 94", fence marked "U. S. 2,737 B. M.".................. 2,736.765

Sinnet School, 4.03 miles south of, on west edge of road, south edge of run, in east root of 15-inch elm tree; copper nail and washer, fence marked "U. S. 2,575.9 B. M.".. 2,575.65

Sinnet School, 3.22 miles south of, on east edge of road, in east root of 22-inch oak tree; copper nail and washer, fence marked "U. S. 2,484.4 B. M."..................... 2,484.17

ONEGO QUADRANGLE: GRANT, PENDLETON, RANDOLPH, AND TUCKER COUNTIES.

(Latitude 38° 45′-39°; Longitude 79° 15′-79° 30′).

From near east border of quadrangle southwest over divide from North Mill Creek to Upper Tract on South Branch of Potomac River.

Third order leveling by Walter McCrea in 1919:

	Feet
Brushy Run, 0.6 mile southwest of, south side of road, in stone step to John Miller's dwelling; chiseled cross, marked "T. B. M. 1,607"	1,606.22
Brushy Run, 1.4 miles southwest of, 50 feet south of gate leading to E. M. Kile's farm, 200 feet south of **Kyle School,** in east side of road, in ledge of rock; bronze tablet stamped "1,523 W. Va."	1,521.770
Brushy Run, 2.4 miles southwest of, west abutment, north end of steel bridge over South Branch of Potomac; chiseled square, bridge marked "T. B. M. 1,422"	1,420.82
Brushy Run, 3.4 miles southwest of, 70 feet southwest of small shanty, east side of road, in large rock; chiseled square, marked "T. B. M. 1,502"	1,500.91
Upper Tract Post-Office, 0.4 mile south of, 5 feet north of south door of schoolhouse, in small rock; bronze tablet stamped "1,495 W. Va."	1,494 254
Brushy Run Post-Office, 0.3 mile north of, 120 feet north of church, west side of road, in root of large oak tree; copper nail and washer, tree marked "T. B. M. 1,379"	1,377.64

From east border of quadrangle northwest along highways to Upper Tract.

Leveling by F. L. Shalibo in 1919:

Upper Tract, 1.7 miles east of, at second-class ╥ road north, in northeast corner of forks, in root of walnut tree; copper nail, painted "1,486.3"	1,485.51
Upper Tract, 1.2 miles east of, on cement bridge over South Branch of Potomac River, on west end of north rail, chiseled square, painted "1,435.2"	1,434.41
Upper Tract, 0.4 mile south of post-office, 5 feet north of south door of schoolhouse, in small rock; bronze tablet stamped "W. Va. 1,495"	1,494.254

From Upper Tract along highways southwest 6 miles up Reeds Creek, thence west over North Fork Mountain to Riverton, thence northeast down North Fork of Potomac River to Mouth of Seneca. Leveled twice.

Leveling by Walter McCrea in 1919:

	Feet.
Upper Tract, 1.4 miles southwest of, 500 feet southeast of William Halloway's dwelling, north side of road, at ford crossing, in large rock; chiseled square, "T. B. M. 1,586" painted on rock	1,584.74
Upper Tract, 2.6 miles southwest of, 2,000 feet south of small dwelling house, west side of road, in root of large maple tree; copper nail and washer, "T. B. M. 1,667" marked on tree	1,665.68
Upper Tract, 4.1 miles southwest of, northeast end of dwelling on Gardner Boggs's farm, 100 feet west of road, in base of chimney; bronze tablet stamped "1,776 W. Va."	1,774.313
(Three bench marks omitted here are in Circleville Quadrangle).	
Upper Tract, 8.1 miles southwest of, northeast side of road, in large boulder; chiseled cross mark, "T. B. M. 2,965" on rock	2,962.46
Upper Tract, 9.0 miles southwest of, northwest side of road, in large flat rock; chiseled square, "T. B. M. 2,905" painted on rock	2,903.13
Upper Tract, 9.9 miles southwest of, 10 feet east of intersection of roads, south side, in large flat rock; bronze tablet stamped "2,273 W. Va."	2,270.593
Upper Tract, 10.9 miles southwest of, south side of road, in root of large chestnut tree; copper nail and washer "T. B. M. 2105" painted on tree	2,102.69
Upper Tract, 11.09 miles southwest of, 200 feet south of Paul Pheris's dwelling, south side of road in root of white oak tree; copper nail and washer, "T. B. M. 2110" painted on tree	2,107.47
(Two bench marks omitted here are in Circleville Quadrangle).	
Riverton, 1 mile northeast of, at intersection of roads, northwest end of wooden bridge, in support log; copper nail and washer, "T. B. M. 1,776" painted on bridge	1,773.89
Riverton, 2.4 miles northeast of, 150 feet north of Sarah E. Harman's barn, 10 feet east of road, in large flat rock; bronze tablet stamped "1,749 W. Va."	1,746.655
Riverton, 3.5 miles northeast of, 10 feet west of road, in large chestnut stump; copper nail and washer, painted "T. B. M. 1,743"	1,740.34

Feet.

Riverton, 4.4 miles northeast of, 845 feet north of ╥ road. east of road, in large rock; chiseled square, "T. B. M. 1,675", painted on fence-post........................ 1,673.05

Macksville, 30 feet north of post-office, 5 feet east of road. in large flat rock; bronze tablet stamped "1,627 W. Va." 1,625.091

Macksville, 0.9 mile northeast of, 100 feet north of ╥ road. southwest end of wooden bridge; copper nail and washer. marked "T. B. M. 1,623"...................... 1,620.79

Macksville, 2.0 miles northeast of, west side of road, in root of large oak tree; copper nail and washer, marked "T. B. M. 1,597"................................. 1,594 36

Mouth of Seneca, 200 feet north of post-office, at intersection of roads, in large boulder; bronze tablet stamped "1,569 W. Va."................................. 1,566.588

From Mouth of Seneca northeast along road down North Fork of South Branch of Potomac River to point 2.6 miles southwest of Hopeville.

Mouth of Seneca, 1.0 mile north of, in triangle, in center of road, small rock; chiseled square, "T. B. M. 1,518" painted on post...................................... 1.515.32

Mouth of Seneca, 1.9 miles northeast of, west side of road, at gate, in root of large oak tree; copper nail and washer, "T. B. M. 1,524" painted on tree............ 1.521.61

Mouth of Seneca, 3.3 miles northeast of, 800 feet south of road leading west, west side of road, in flat rock; bronze tablet stamped "1,473 W. Va."......................... 1.470.701

Mouth of Seneca, 4.6 miles northeast of, 30 feet west of Sawmill Run, 15 feet south of road, in root of large sycamore tree; copper nail and washer, "T. B. M. 1,425" painted on tree...................................... 1.422.43

Mouth of Seneca, 5.6 miles northeast of, 60 feet south of **Mount Pleasant U. B. Church**, 10 feet west of road, in large boulder; chiseled cross mark, "T. B. M. 1,476" marked on rock...................................... 1.473.39

Mouth of Seneca, 6.7 miles northeast of, 70 feet south of **Carr School**, 40 feet west of road, in large pointed boulder; bronze tablet stamped "1,694 W. Va."........ 1,691.397

Mouth of Seneca, 7.7 miles northeast of, 30 feet south of Zeke Run, 10 feet east of road, in large boulder; chiseled square, marked "T. B. M. 1,587"................. 1,584.68

Mouth of Seneca, 8.7 miles northeast of, 500 feet southwest of Will Heavener's dwelling, east side of road, in south end of wooden culvert; copper nail and washer, "T. B. M. 1,446" on fence...................................... 1,443.06

Mouth of Seneca, 9.8 miles northeast of, 375 feet west of Mill Run, 10 feet south of road, in large boulder; bronze tablet stamped "1,379 W. Va."................. 1.376.333

	Feet.
Mouth of Seneca, 10.9 miles northeast of, west side of road, in small rock; chiseled square, "T. B. M. 1,529" painted on tree	1,526.38
Mouth of Seneca, 11.9 miles northeast of, 800 feet north of **Long Hollow School**, east side of road, in root of large oak tree; copper nail and washer, marked "T. B. M. 1,346"	1,343.14

From north border of quadrangle south to Hopeville.[1]

Scherr, 15.6 miles south of, 700 feet south of where road crosses Jordan Run, at turn in road, west side of road, in large flat rock; bronze tablet stamped "1285 W. Va."	1,284.254
Scherr, 16.6 miles south of, 25 feet south of private road, at entrance to **Hopeville Gap**, west side of road, in large flat rock; chiseled square, rock marked "T. B. M. 1,385"	1,384.87

From Hopeville east along highway.

(Line enters Petersburg Quadrangle).

Hopeville, 15 feet west of Jordan Run, 115 feet south of Perry Robaugh's dwelling, in root of large sycamore tree; copper nail and washer, "T. B. M. 1,106" marked on tree	1,105.44

From point 2.6 miles southeast of Hopeville along highways northeast to Hopeville.
Leveled twice.

(New) Hopeville, 1.0 mile southwest of, 180 feet north of Red Creek road, west side of road, in large rock; bronze tablet stamped "1,477 W. Va."	1,474.401
(New) Hopeville, southeast of Amos Dolly's storehouse, north side of road, in root of large maple tree; copper nail and washer, "T. B. M. 1,152" painted on tree	1,149.18
Hopeville, 0.2 mile south of, opposite **Hopeville School**, east of road, in root of large poplar tree; copper nail and washer, marked "T. B. M. 1,122"	1,119.11
Hopeville, 15 feet west of Jordan Run, 115 feet south of Perry Robaugh's dwellling, south of road, in root of large sycamore tree; copper nail and washer, "T. B. M. 1,106" on tree	1,105.438

[1]Part of line from Scherr in which an error of 0.6 foot has been adjusted in Greenland Gap, Davis, and Onego Quadrangles.

From Mouth of Seneca along highways northwest to Days Mills (Harperton Post-Office).

(Line enters Horton Quadrangle.)

	Feet.
Mouth of Seneca Post-Office, 200 feet north of post-office, at intersection of roads, in large boulder; bronze tablet stamped "1,569 W. Va."..............................	1,566.588
Mouth of Seneca Post-Office, 1.0 mile west of, north side of road, in large rock; chiseled square, "T. B. M. 1,748" painted on rock......................................	1,745.55
Mouth of Seneca Post-Office, 2 miles west of, 400 feet west of road leading south, south side of road, in large boulder; chiseled square, "T. B. M. 1,757" painted on boulder...	1,754.88
Onego, 30 feet north of J. R. Adamson's store, 100 feet south of Roaring Creek, east side of road, in large boulder; bronze tablet stamped "1,764 W. Va."..................	1,761.139
Onego, 1.0 mile northwest of, opposite Luther Hoffman's dwelling, 15 feet west of road, in large flat rock; chiseled square, marked "T. B. M. 1,841"..................	1,838.82
Onego, 2.0 miles northwest of, north side of road, in large boulder; chiseled square, boulder marked "T. B. M. 1,929"...	1,926.88
Onego, 3.1 miles northwest of, 500 feet south of wooden bridge over Horsecamp Run, east side of road, in large flat rock; bronze tablet stamped "2,170 W. Va.".......	2,167.501
Onego, 4.1 miles northwest of, in ledge of rocks, east side of road; chiseled square, "T. B. M. 2,661" painted on rocks.	2,658.71
Onego, 5.2 miles northwest of, 700 feet south of road leading east, west side of road, in small rock; chiseled square, "T. B. M. 3,212" painted on telephone-pole..............	3,209.06
Onego, 6.4 miles northwest of, 250 feet east of road leading south, north of road, in large boulder; bronze tablet stamped "2,977 W. Va."...............................	2,974.180
Harperton Post-Office, 15 feet west of J. C. Harman and Company's store, north side of road, in large boulder; chiseled square, "T. B. M. 2,752" painted on boulder...	2,750.02

From west border of quadrangle east along highways to point 1.0 mile southwest of (New) Hopeville.

Red Creek Junction, 1.8 miles southeast of, at gate leading to J. S. Mullennux's farm, 100 feet west of Big Run, south side of road, in flat rock; bronze tablet stamped "2,355 W. Va.".....................................	2,352.915

Feet.

Red Creek Junction, 2.9 miles east of, 550 feet east of Henry Hoffman's dwelling, north side of road; chiseled square, painted "T. B. M. 2,325" on fence-post................. 2,322.23

Red Creek Junction, 4.0 miles east of, south side of railroad grade, in root of large beech tree; copper nail and washer, marked "T. B. M. 2,358"...................... 2,355.85

Laneville, 100 feet west of post-office, 125 feet north of road, in large pointed rock; bronze tablet stamped "2,516 W. Va.".. 2,513.758

Laneville, 1.1 miles east of, south side of Red Creek, at road crossing, in large rock; chiseled square, painted "T. B. M. 2,612"..................................... 2,609.27

Laneville, 2.1 miles east of, on Red Creek road, south side, in large flat rock; chiseled square, painted "T. B. M. 2,997"... 2,994.39

(New) Hopeville, 7.4 miles west of, on Red Creek road, north side of road, in large boulder; chiseled square, "T. B. M. 3,734" painted on rock.............................. 3,731.22

(New) Hopeville, 7.1 miles west of, on Red Creek road, on Monongahela National Forest Reservation, north side of road, in large boulder; bronze tablet stamped "3,888 W. Va.".. 3,885.700

(New) Hopeville, 6.1 miles west of, on Red Creek road, 50 feet east of **Big Spring,** north side of road, in large boulder; chiseled square, "T. B. M. 3,919" on rock...... 3,916.29

(New) Hopeville, 5.1 miles west of, on Red Creek road, 1,000 feet north of woods road, west side, in large rock; chiseled square, "T. B. M. 3,368" painted on rock...... 3,365.68

(New) Hopeville, 4.1 miles west of, on Red Creek road, 1,500 feet west of Robert Heavener's cabin, south side of road, in large rock; bronze tablet stamped "2,838 W. Va."... 2,835.037

(New) Hopeville, 3.1 miles west of, on Red Creek road, north side, in large ledge of rocks; chiseled square, marked "T. B. M. 2,442" on rocks............................ 2,438.88

(New) Hopeville, 2.1 miles southwest of, on Red Creek road, south side, in ledge of rocks; chiseled cross, marked "T. B. M. 1,927"... 1,924.53

(New) Hopeville, 1.0 mile southwest of, 180 feet north of Red Creek road, west side of road, in large flat rock; bronze tablet stamped "1,477 W. Va."................. 1,474,401

Primary leveling by E. E. Harris in 1921:

From Upper Tract south along highways into Circleville Quadrangle.

Brushy Run, 3.4 miles southwest of, 70 feet southwest of small shanty, side of road, in large rock; chiseled square, marked "T. B. M. 1,502"....................... 1,500.91

Feet.

Upper Tract Post-Office, 0.4 mile south of, 5 feet north of south door of schoolhouse, in small rock; bronze tablet stamped "1,495 W. Va."............................... 1,494.254

Upper Tract Post-Office, 1.22 miles south of, on west edge of road, in south root of oak tree, 5 feet in diameter; copper nail and washer, fence marked "U. S. 1,482.8 B. M."... 1,482.85

Upper Tract Post-Office, 2.19 miles south of, on west edge of road, in front of home of Joe Alt, in south root of 36-inch oak tree; copper nail and washer, fence marked "U. S. 1,501.1 B. M."................................. 1,501.15

Upper Tract Post-Office, 2.79 miles south of, 2.92 miles north of **Ruddle,** 50 feet west of road center, 30 feet south of ╦ road east, in top of concrete post; bronze tablet stamped "W. Va. 1921 H 71", fence marked "U. S. 1,488.9 B. M."... 1,488.930

Witness bench mark, 73.5 feet N. 60° E. of tablet, in south root of 18-inch walnut tree; copper nail and washer... 1,485.98

PETERSBURG QUADRANGLE: GRANT, HARDY, AND PENDLETON COUNTIES.

(Latitude 38° 45'-39°; Longitude 79°-79° 15').

Third order leveling by Walter McCrea in 1919:

From near Hopeville, Onego Quadrangle, northeast along highways near north border of quadrangle into Greenland Gap Quadrangle northwest of Petersburg.

Feet.

Hopeville, 1.3 miles east of, 500 feet east of road leading to Joseph Turner's farm, 5 feet north of road, in large rock; bronze tablet stamped "1,244 W. Va."............ 1,243.348

Hopeville, 2.5 miles east of, 1,500 feet east of two small shanties, 15 feet north of road, in large flat rock; chiseled cross mark, "T. B. M. 1081" marked on stone...... 1,081.12

Hopeville, 3.6 miles east of, 150 feet east of wooden bridge, north side of road, on large rock; chiseled cross mark, stone marked "T. B. M. 1055"........................ 1,054.81

Third order leveling by F. L. Shalibo in 1919:

From near northeast corner of quadrangle west along Baltimore and Ohio Railroad to Petersburg.

Moorefield, 6.3 miles south of, 500 feet east of **Spring Brook** flag-station, on Baltimore and Ohio Railroad, in concrete foundation of silo; bronze tablet stamped "W. Va. 859" 859.195

Moorefield, 7.2 miles south of, on Baltimore and Ohio Railroad, 6.0 miles east of **Petersburg,** at small stream crossing, on east edge of track, in top of cement culvert; chiseled square, painted "876.9"...................... 875.59

	Feet.
Petersburg, 5.0 miles east of, on Baltimore and Ohio Railroad, at **Durgon Station**, in north end of west bent of bridge 583; iron pin, painted "876.9"	875.91
Petersburg, 4.5 miles east of, 300 feet south of track, in base of cement silo, at Seymour Fisher's residence; bronze tablet stamped "W. Va. 893"	891.992
Petersburg, 2.0 miles east of, on Baltimore and Ohio Railroad, at west end of Gap, at sharp curve on south edge of track, in ledge of rock; chiseled square, painted "914.8"	913.80
Petersburg, 1.5 miles east of, in northeast corner of wooden bridge over Mill Creek, in wooden support; copper nail, painted "913.5"	912.44
Petersburg, 400 feet west of railroad station, in center of north timber of base of water-tank; copper nail, painted "936.0"	935.20
Petersburg, at north end of Main Street, in base of water-tank; on west side; bolt, painted "1,037.0"	1,036.21
Petersburg, 50 feet west of court-house, 50 feet south of road, in cement block; bronze tablet stamped "W. Va. 938"	936.957

Third order leveling by Walter McCrea in 1919:

From Petersburg southwest along highways to west border of quadrangle.

(Line enters Onego Quadrangle).

Petersburg, at railroad crossing at station; top of south rail.	932.3
Petersburg, 1.1 miles southwest of, northwest side of road, in root of sycamore tree; copper nail and washer, tree marked "T. B. M. 1000"	999.56
Petersburg, 2 miles southwest of, 50 feet north of Ben Jenkins's dwelling, on west side of road, on small ledge of rocks; chiseled square, "T. B. M. 1101" marked on post.	1,100.47
Petersburg, 3.1 miles southwest of, north end of east side of concrete bridge over small stream; bronze tablet stamped "1086 W. Va."	1,085.470
Petersburg, 3.9 miles southwest of, north side of road, in large iron culvert; chiseled cross, marked "T. B. M." 1018"	1,017.47
Petersburg, 4.7 miles southwest of, at gate leading to field of J. Ed. Bergdall, east side of road, in root of cedar tree; copper nail and washer, marked "T. B. M. 1040"	1,038.90
Petersburg, 5.7 miles southwest of, south abutment of east side of concrete bridge over North Mill Creek; bronze tablet stamped "1051 W. Va."	1,050.492
Pansy Post-Office, 0.5 mile south of, east side of road, opposite gate to field, in root of large oak tree; copper nail and washer, tree marked "T. B. M. 1093"	1,091.67

Feet.

Pansy Post-Office, 1.4 miles south of, 290 feet west of **Landes Post-Office,** in south end of wooden bridge; copper nail and washer, marked "T. B. M. 1129".................. 1,128.00

Landes Post-Office, 1.6 miles southwest of, 50 feet southeast of O. B. Kimble's dwelling, east side of road, in flat rock over culvert; bronze tablet stamped "1155 W. Va.".... 1,154.287

Landes Post-Office, 2.8 miles southwest of, east side of road, opposite gate to field, in root of pine tree; copper nail and washer, marked "T. B. M. 1210"................... 1,208.58

Landes Post-Office, 3.6 miles southwest of, 120 feet south of Lige Judy's dwelling, northwest side of road, on large rock; chiseled square, marked "T. B. M. 1226"........ 1,225.17

Landes Post-Office, 4.6 miles south of, at **Alt Schoolhouse,** 80 feet north of road, in southeast end of stone foundation; bronze tablet stamped "1246 W. Va."............ 1,245.430

Third order leveling by F. L. Shalibo in 1919:

From Petersburg along highways south to Wine Spring School, thence northeast to east border of quadrangle.

Petersburg, 1.0 mile south of, on Turkey Knob road, in southwest corner of bridge over small run, in stone abutment; chiseled square, painted "974.8"....................... 973.95

Petersburg, 1.7 miles south of, on Turkey Knob road, at three corners, in northwest corner of forks, in root of small tree; copper nail, painted "1164.4".................... 1,163.64

Petersburg, 2.9 miles south of, at country store, 150 feet west of road, under south sill at stable door of Isaac Shobe's barn; bronze tablet stamped "W. Va. 944"............. 943.393

Petersburg, 3.6 miles south of, on west edge of road, opposite ╦ road east, in root of large tree; copper nail, painted "969.1".. 968.32

Petersburg, 4.5 miles south of, 0.20 mile north of **Dorcas School,** in northeast corner of bridge over small stream, in wooden support; copper nail, painted "1025.7"...... 1,024.94

Petersburg, 4.9 miles south of, 100 feet north of **Dorcas Post-Office,** on west side of road, in south wall at southwest corner of Lutheran parsonage; bronze tablet stamped "W. Va. 1067"...................................... 1,065.850

Dorcas, 1.0 mile south of, 80 feet north of ╦ road east, 100 feet south of D. C. Mongold's residence, on east edge of road, in root of large tree; copper nail, painted "1028.4".. 1,027.64

Dorcas, 2.1 miles south of, 100 feet south of **Hedricks Chapel,** on east edge of road, in root of 10-inch pine tree; copper nail, painted "1069.6"............................... 1,068.77

Feet.

Rough Run School, 0.7 mile north of, 50 feet south of Rough Run, opposite ╥ road east, in root of large tree; copper nail, painted "1111.1".................................... 1,110.28

Rough Run School, at three corners, at southwest corner in south foundation of **Rough Run School**; bronze tablet stamped "W. Va. 1155"................................ 1.154.655

Rough Run School, 0.9 mile southeast of, on second-class road, 500 feet south of old farm buildings, at top of small hill, on west edge of road, in large boulder; chiseled square, painted "1366.3"........................... 1,365.54

Rough Run School, 1.7 miles southeast of, on second-class road, at ╥ road north, at northwest corner of bridge, in large boulder; chiseled square, painted "1622.6".... 1,621.82

Rough Run School, 2.5 miles southeast of, at three corners, in center of forks, 8 feet north of rail fence, in large boulder; bronze tablet stamped "W. Va. 1992"......... 1,991.551

Rough Run School, 3.8 miles southeast of, at top of first mountain, on southwest edge of road, in root of locust tree; copper nail, painted "2385.1"...................... 2,384.33

Rough Run School, 4.7 miles southeast of, at bottom of ravine, 200 feet north of house, at sharp bend in road, in root of large oak tree; copper nail, painted "2015.4"... 2,014.60

Rough Run School, 5.5 miles south of, opposite second-class road to Isaac Simmons's residence, 8 feet west of road, in large boulder; bronze tablet stamped "W. Va. 2291".. 2,290.155

Wine Spring School, 2.1 miles northwest of, 0.65 mile south of Isaac Simmons's residence, on horseback trail, near head of ravine, 200 feet north of gate, in rock; chiseled square, painted "2366.1"............................... 2,365.28

Wine Spring School, 1.1 miles west of, on horseback trail, at northwest corner of old cabin, in small rock; chiseled square, painted "1790.1"............................... 1,789.26

Wine Spring School, 20 feet northwest of, in top of large rock; bronze tablet stamped "W. Va. 1217"............ 1,216.150

Wine Spring School, 0.9 mile northeast of, in front of **Zion Church**, in root of hickory tree; copper nail, painted "1191.7"... 1,190.86

Wine Spring School, 1.9 miles northeast of, 0.45 mile south of **Peru**, near J. Dasher's residence, on south side of small stream, in root of large tree; copper nail, painted "1155.1"... 1,154.20

Peru, at northwest corner of flour mill, in old millstone; bronze tablet stamped "W. Va. 1136".................. 1,134.681

Peru, 1.3 miles northeast of, at ╥ road west, on east edge of road, in large rock; chiseled square, painted "1159.9".. 1,158.99

Peru, 2.4 miles northeast of, in front of C. Cowger's residence, on west edge of road, in root of large tree; copper nail, painted "1105.9"................................... 1,104.98

Feet.

Peru, 3.5 miles northeast of, at **Blue Rock School**, in east side at southeast corner, in stone foundation; bronze tablet stamped "W. Va. 1064" 1,062.885

Peru, 4.6 miles northeast of, 40 feet south of ╦ road west, 10 feet west of highway, in small rock; chiseled square, painted "1044.9" 1,044.01

Peru, 5.7 miles northeast of, on west edge of road, in small rock; chiseled square, painted "1033.7" 1,032.79

Peru, 6.9 miles northeast of, on south fork of road, at field roads, 40 feet from main road, near field gate, in large boulder; bronze tablet stamped "W. Va. 992" 991.378

Peru, 7.8 miles northeast of, in front and opposite S. Ray Ours's residence, on west edge of road, in root of sycamore tree; copper nail, painted "996.9" 995.98

Peru, 9.0 miles northeast of, in front of G. V. Wolfe's store, at **Bass Post-Office**, 3 feet from northeast corner of wooden bridge over small stream, in root of maple tree; copper nail, painted "984.9" 983.92

From Rough Run southwest along highways to Klines Crossroads Mill Gap, thence west to west border of quadrangle.

(Line goes to Upper Tract, Onego Quadrangle).

Rough Run School, 1 mile south of, near old barn, 20 feet south of small bridge, on west edge of road, in root of walnut tree; copper nail, painted "1187.5" 1,186.68

Rough Run School, 1.9 miles south of, at top of hill, on east edge of road, in root of old oak tree; copper nail painted "1263.3" 1,262.54

Rough Run School, 3.3 miles south of, in east foundation at northeast corner of **Judy School**, in stone; bronze tablet stamped "W. Va. 1253" 1,252.645

Rough Run School, 4.1 miles south of, at top of small hill, on east edge of road, in large rock; chiseled square, painted "1273.7" 1,272.86

Rough Run School, 5.2 miles south of, 0.25 mile north of sawmill, on west edge of road, in root of large oak tree; copper nail, painted "1374.9" 1,374.07

Rough Run School, 6.4 miles south of, in doorstep to **Borror School**, in stone; bronze tablet stamped "W. Va. 1453".. 1,451.770

Kline, 3.5 miles north of, at top of small hill, on west edge of road, in root of large oak tree; copper nail, painted "1494.7" 1,493.90

Kline, 2.5 miles north of, on west end of small wooden bridge in front of Isaac Harman's residence; copper nail, painted "1558.5" 1,557.66

Feet.

Kline, 2.1 miles north of, at three corners, 80 feet west of forks, on south edge of ╦ road, in large stone; bronze tablet stamped "W. Va. 1576" 1,575.344

Kline, 1.1 miles north of, in front of A. O. Lough's residence, on east edge of road, in root of large walnut tree; copper nail, painted "1591.5" 1,590.72

Kline, 100 feet northwest of post-office, on east edge of road, in large boulder; chiseled square, painted "1,616.8" 1,616.02

Upper Tract, 3.3 miles east of, at **Kline Crossroads**, on north edge of, 200 feet east of C. A. Mitchell's residence, in large rock; bronze tablet stamped "W. Va. 1725" 1,724.528

Upper Tract, 2.7 miles east of, in front of **Schmucker School**, in triangle at three corners, in root of oak tree; copper nail, painted "1586.9" 1,586.12

From Kline Crossroads south along highway to south border of quadrangle.

(Line enters Fort Seybert Quadrangle).

Upper Tract, 3.3 miles east of, at **Kline Crossroads**, on north edge of, 200 feet east of C. A. Mitchell's residence in large rock; bronze tablet stamped "W. Va. 1725" 1,724.528

Kline, 1.6 miles southeast of, at top of first hill on west edge of road, in root of small pine tree; copper nail, painted "2188.7" 2,187.86

Kline, 2.6 miles southeast of, on west edge of road, on north edge of lane to Cook's farm, in root of gum tree; copper nail, painted "2382.7" 2,381.84

From Peru along highways east to Virginia-West Virginia State line, thence southwest along same on ridge to point 3 miles south of Mount Pleasant School, thence west to Lick Run.

Peru, at northeast corner of flour mill, in old millstone; chiseled square, painted "1135.5" 1,134.60

Peru, 0.8 mile southeast of, in southeast corner of ╦ road south, in root of 10-inch tree; copper nail, painted "1225.7" 1,224.78

Peru, 2.2 miles southeast of, on Doveville road, 10 feet north of road, in root of 20-inch oak tree; copper nail, painted "1419.2" 1,418.32

Peru, 2.9 miles southeast of, on Doveville road, at north edge of road, in large boulder; bronze tablet stamped "W. Va. 1636" 1,635.206

Peru, 3.9 miles southeast of, at point of mountain, on east edge of road, in ledge of rock; chiseled square, painted "2012.6" 2,011.64

	Feet.
Peru, 4.9 miles southeast of, 0.6 mile west of State line, on northeast edge of road, in ledge of rock; chiseled square, painted "2392.1"	2,391.18
Peru, 5.5 miles southeast of, on Virginia-West Virginia State line, 100 feet south of road forks, in front of Silas Dove's residence, in large rock near oak tree; bronze tablet stamped "W. Va. 2424"	2,423.094
Dove triangulation station, 1.8 miles north of, on Virginia West Virginia State line, at top of **Pine Knob**, 15 feet east of road, in root of oak tree; copper nail, painted "2747.0"	2,746.03
Dove triangulation station, 0.8 mile east of, at east end of clearing, on south edge of road, in root of oak tree; copper nail, painted "2841.1"	2,840.19
Dove triangulation station, 100 feet west of John Dove's barn, in small stone; bronze tablet stamped "W. Va. 3010"	3,009.002
Mount Pleasant School, 100 feet west of schoolhouse, on Virginia-West Virginia State line, in northeast corner of crossing, in root of oak tree; copper nail, painted "2808.6"	2,807.66
Mount Pleasant School, 1.2 miles southwest of, on Virginia-West Virginia State line, at driveway to Casper Turner's residence, in northeast corner of forks, in root of large oak tree; copper nail, painted "3059.8"	3,058.85
Mount Pleasant School, 2.2 miles south of, on Virginia-West Virginia State line, at sharp bend in road, opposite John Getz's residence, on east edge of road, in root of oak tree; copper nail, painted "3016.4"	3,015.39
Mount Pleasant School, 3.0 miles south of, on West Virginia-Virginia State line, at head of Camp Run, in northeast corner of crossroads, 8 feet north of road, in large boulder; bronze tablet stamped "W. Va. 3017"	3,015 545
Virginia-West Virginia State line, 0.9 mile west of, on south edge of road, in root of apple tree; copper nail, painted "2792.0"	2,791.07
Virginia-West Virginia State line, 1.9 miles west of, at sharp bend in road, on south edge, in root of hickory tree; copper nail, painted "2180.2"	2,179.25
South Fork road, at junction of Camp Run road, 60 feet south of forks, on east edge of road, in root of locust tree; copper nail, painted "1427.0"	1,426.01

Third order leveling by Walter McCrea in 1919:

From Wine Spring School southwest along highways to south border of quadrangle. (Line enters Fort Seybert Quadrangle).

Wine Spring School, 20 feet northwest of, in top of large rock; bronze tablet stamped "1217 W. Va."	1,216.150

Feet.

Wine Spring School, 1.1 miles south of, in door-sill of George Dasher's cattle scales, west side of road; copper nail and washer, painted "T. B. M. 1283" on building...... 1,282.02

Wine Spring School, 2.1 miles south of, 1,500 feet north of B. Souder's gate to dwelling, east side of road, in root of maple tree; copper nail and washer, "T. B. M. 1297" painted on tree.................................... 1,296.04

Wine Spring School, 3.3 miles south of, at Cyrus Mitchell's barnyard gate, west side of road, in small rock; bronze tablet stamped "1344 W. Va."............................ 1,343.308

Wine Spring School, 4.3 miles south of, 105 feet south of intersection of roads, 20 feet east of road, in root of locust tree; copper nail and washer, "T. B. M. 1427" painted on tree.................................... 1,426.01

SPRUCE KNOB QUADRANGLE: PENDLETON, POCAHONTAS, AND RANDOLPH COUNTIES.

(Latitude 38° 30′-38° 45′; Longitude 79° 30′-79° 45′).

Third order leveling by E. E. Harris in 1921:

From Circleville, Circleville Quadrangle, along highways southwest and south to Dry Run Post-Office, thence southeast into Circleville Quadrangle.

Circleville, 0.97 mile south of, 30 feet west of road, on south side of drain, on top of large boulder; chiseled square, fence marked "U. S. B. M. 2,095.3".................... 2,095.31

Circleville, 1.71 miles south of, in northeast corner of sharp turn in road, 20 feet east of run, on top of boulder; chiseled square, fence marked "2,158.7"................ 2,158.71

Circleville, 2.59 miles south of, on west edge of road, on south edge of lane through gate, on top of boulder; chiseled square, gate-post marked "U. S. B. M. 2,160.5".. 2,160.45

Circleville, 3.19 miles south of, known as Big Run, in **Big Run Church yard,** 30 feet west of road, 86 feet east of northeast corner of church, in top of large boulder; bronze tablet stamped "2206 W. Va. 1921 H 69", fence marked "U. S. B. M. 2,206.4"......................... 2,206.327

Witness bench mark, S. 75° W. of tablet, on top of outcrop of rock; chiseled square.............................. 2,206.66

Circleville, 3.83 miles south of, on east edge of road, 250 feet north of foot-bridge, in south end of triangle formed by forks of lane east to farmhouse, on top of boulder; chiseled square, fence marked "U. S. B. M. 2,216.5".... 2,216.48

Circleville, 4.56 miles south of, 1.10 miles northwest of **Dry Run Post-Office,** on north edge of ╥ road east, 50 feet east of north and south road, in west root of 30-inch walnut tree; copper nail and washer, tree marked "U. S. B. M. 2,252.1".. 2,252.05

	Feet.
Dry Run Post-Office, about 500 feet west of, on north edge of road, east edge of run, west edge of lane north through gate, on top of large boulder; chiseled square, fence marked "U. S. B. M. 2,379.6"	2,379.55
Dry Run Post-Office, 0.88 mile southeast of, 40 feet east of road, 50 feet north of second-class road east, in top of boulder; bronze tablet stamped "'2492 W. Va. 1921 H 70," fence-post marked "U. S. B. M. 2,491.7"	2,491.619
Witness bench mark, 16.7 feet south 10° east of tablet, on top of boulder; chiseled square	2,492.16
Dry Run Post-Office, 1.77 miles southeast of, on north edge of road, west of bridge over Dry Run, on top of boulder; chiseled square, fence marked "U. S. B. M. 2,625.3"	2,625.25
Dry Run Post-Office, 2.49 miles southeast of, in forks of road at Weimer's blacksmith shop, on top of small outcrop of rock; chiseled square, telephone-pole, marked "U. S. B. M. 2,800.9"	2,800.81
Dry Run Post-Office, 3.15 miles southeast of, 30 feet west of road center, in line with lane east through gate to farmhouse, in top of concrete post; bronze tablet stamped "3142 W. Va. 1921 H 81", fence-post marked "U. S. B. M. 3,141.7"	3,141.532
Witness bench mark, 37.8 feet west of tablet, in north root of 30-inch apple tree; copper nail and washer	3,140.95
Dry Run Post-Office, 3.69 miles southeast of, on east edge of road, in gap, in top of stump of telephone-pole; copper nail and washer, fence marked "U. S. B. M. 3,401.7"	3,401.54
Dry Run Post-Office, 4.51 miles southeast of, on east edge of road, in bed of run, on top of ledge of rock; chiseled square, ledge marked "U. S. B. M. 3,076.7"	3,076.50
Cave Post-Office, 2.26 miles southwest thence 2.78 miles northwest of, at forks of road southeast to Crabbottom, 50 feet east of road center, in top of large boulder; bronze tablet stamped "2834 W. Va. 1921 H 80", gate-post marked "U. S. B. M. 2,834.2"	2,834.108
Witness bench mark, 37.3 feet west of tablet, in east root of 15-inch walnut tree; copper nail and washer	2,834.61

Third order leveling by E. E. Harris in 1921:

From Horton Quadrangle along highways southwest to Osceola, thence northwest into Horton Quadrangle.

Horton, 7.19 miles south of, at north end of railroad trestle, in top face of sill between tracks; copper nail and washer, guard-rail marked "U. S. B. M. 3,225.3"	3,225.55
Horton, 8.22 miles south of, on east side of track, near south end of fenced-in field, on top of boulder; chiseled square, fence marked "U. S. B. M. 3,284.3"	3,284.52

Feet.

Horton, 8.96 miles south of, 15 feet south of track, 350 feet east of switch, in sharp turn in railroad, on top of large flat boulder; chiseled square, telegraph-pole marked "U. S. B. M. 3,330.7" 3,330.90

Witness bench mark, 33 feet north 10° west of tablet, on top of boulder; chiseled square 3,427.40

Horton, 9.70 miles south of, 1.62 miles northeast of **Osceola**, 15 feet east of track, in top of large sandstone boulder; bronze tablet stamped "3430 W. Va. 1921 H 102", boulder marked "U. S. B. M. 3,430" 3,430.263

Osceola, 0.68 mile north of, 30 feet west of road, north side of wire fence, just west of gate, on top of boulder; chiseled square, telephone-pole marked "U. S. B. M. 3,488.3" 3,488.48

Osceola, 200 feet west of post-office, 100 feet west of ╥ road north, 40 feet north of center of road, in south root of 7-inch elm tree; copper nail and washer. tree marked "U. S. B. M. 3,513.1" 3,513.29

Osceola, 1.35 miles northwest of, 500 feet northwest of **Osceola School**, 50 feet east of center of road, on north side of low gap in center of flat boulder; bronze tablet stamped "3595 W. Va. 1921 H 103", fence-post marked "U. S. B. M. 3,594.8" 3,595.091

Witness bench mark, 33.6 feet south 75° west of tablet, inside fence line, on top of boulder; chiseled square 3,594.19

Osceola, 2.10 miles northwest of, 60 feet north of road. 120 feet west of gate to farmhouse, on top of large boulder; chiseled square, boulder marked "U. S. B. M. 3,321.4" .. 3,321.64

Osceola, 3.20 miles northwest of, on north edge of road, in roadbed, 10 feet east of southeast corner of shanty, on top of boulder; chiseled square, corner of shanty marked "U. S. B. M. 3,171.4" 3,171.62

Osceola, 3.81 miles northwest of, on north edge of road, on east edge of lane north through gate, on top of small boulder; chiseled square, telephone-pole marked "U. S. B. M. 3,138.4" 3,138.66

Osceola, 4.84 miles northwest of, 80 feet west of Laurel Fork, 55 feet south of sharp turn in road at foot of mountain, 35 feet west of old log road, in top of boulder set in place; bronze tablet stamped "3102 W. Va. 1921 H 104", post marked "U. S. B. M. 3,101.4" 3,101.625

Witness bench mark, 10.7 feet north 20° east of tablet, in top of small boulder; chiseled square 3,101.29

Osceola, 5.60 miles northwest of, on east edge of road, in west root of 12-inch elm tree; copper nail and washer, tree marked "U. S. B. M. 3,385.4" 3,385.65

From near Bartow, Durbin Quadrangle, northeast along highways to point west of Osceola.

Feet.

Thornwood, 0.57 mile southwest of, west side of track, 25 feet south of second-class road crossing, top of rock ledge; chiseled square, rock marked "U. S. B. M. 2,842.9"...... 2,843.13

Thornwood, 900 feet west of station, 40 feet north of track, at angle in county road, east side of, in top of rock set in place; bronze tablet stamped "2871 W. Va. 1921 H 123", fence-post marked "U. S. B. M. 2,870.9"........... 2,871.179

Witness bench mark, 50.7 feet north of tablet, in top of rock at south end of plank walk; chiseled square.......... 2,873.80

Thornwood, 0.87 mile north of, on south edge of road, 20 feet east of gate to pasture, on top boulder; chiseled square, gate-post marked "U. S. B. M. 2,908.7"................. 2,908.99

Thornwood, 1.70 miles north of, 30 feet west of road, in north root of 20-inch spruce tree; copper nail and washer, tree marked "U. S. B. M. 3,147.7".............. 3,147.88

Thornwood, 2.64 miles north of, on east edge of road, in west root of 10-inch oak tree; copper nail and washer, tree marked "U. S. B. M. 3,671"....................... 3,671.04

Thornwood, 3.24 miles north of, in forks of Y road, on top of **Bruner Mountain,** set in top of concrete post; bronze tablet stamped "4094 W. Va. 1921 H 124", tree marked "U. S. B. M. 4,094.1"................................. 4,094.012

Witness bench mark, 68 feet north 30° east of tablet, in south root of 18-inch elm tree; copper nail and washer 4,100.27

Thornwood, 4.07 miles north of, on north edge of road, on hill in road, in south root of 12-inch maple tree; copper nail and washer, tree marked "U. S. B. M. 4,076.5"...... 4,076.50

Thornwood, 4.78 miles north of, east edge of road, 200 feet south of corner fence-post, in west root of 12-inch tree; copper nail and washer, tree marked "U. S. B. M. 3,994.6"... 3,994.67

Thornwood, 5.67 miles north of, 80 feet south of road center, in north root of forked chestnut tree; copper nail and washer, tree blazed and marked "U. S. B. M. 3,912.5".. 3,912.62

Thornwood, 6.16 miles north of, 30 feet east of road center, on top of high cleared knob, in top of concrete post; bronze tablet stamped "3914 W. Va. 1921 H 125", tree marked "3,914.3"................................. 3,914.424

Witness bench mark, 49 feet north 40° west of tablet, in east root of 15-inch maple tree; copper nail and washer.... 3,914.24

Thornwood, 7.40 miles north of, 20 feet east of road center, 20 feet south of gate, in fence line, in west root of 20-inch oak tree; copper nail and washer, tree marked "U. S. B. M. 3,827.9"................................ 3,828.11

Feet.

Thornwood, 8.21 miles north of, 20 feet east of road center, at south edge of big clearing, on top of boulder; chiseled square, boulder marked "U. S. B. M. 3,729.7"........... 3,729.91

Thornwood, 8.76 miles north of, 0.84 mile west and 5.98 miles south of **Osceola,** 50 feet south of road center, 80 feet north of wire fence line, 40 feet east of rail fence line, 456 feet east of sheep-shed, in top of concrete post; bronze tablet stamped "3739 W. Va. 1921 H 126", fence marked "U. S. B. M. 3,738.5"......................... 3,738.763

Witness bench mark, 95.3 feet south 15° west of tablet, in east root of locust tree; copper nail and washer........ 3,738.78

Osceola, 0.84 mile west by 5.26 miles south of, in center of trail, in line with trail east through gate, 150 feet north of scales, on top of large boulder; chiseled square, fence marked "U. S. B. M. 3,811.3"......................... 3,811.56

Osceola, 0.84 mile west by 4.28 miles south of, on east edge of road, in sharp turn in road, 0.23 mile north of **Stark School,** on top of large boulder, south of run crossing road; chiseled square, boulder marked "U. S. B. M. 3,677.9".. 3,678.17

Osceola, 0.84 mile west by 3.48 miles south of, 50 feet southeast of road forks, 600 feet northeast of C. Lance's dwelling, 10 feet west of fence line, set in top of concrete post; bronze tablet stamped "3637 W. Va. 1921 H 127", gate-post marked "U. S. B. M. 3,636.5"................. 3,636.823

Witness bench mark, 83.5 feet west of tablet, on top of large boulder; chiseled square................................ 3,633.03

Osceola, 0.84 mile west by 2.72 miles south of, 30 feet north of road, 20 feet south of wire fence line, 50 feet west of gate, on top of large boulder; chiseled square, boulder marked "U. S. B. M. 3,707.6"......................... 3,707.85

Osceola, 0.84 mile west by 1.85 miles south of, on south edge of road, 40 feet east of gate, in angle of road, on top of boulder; chiseled square, boulder marked "U. S. B. M. 3,651.7".. 3,651.97

Osceola, 0.84 mile west by 0.90 mile south of, on west edge of road, in north root of 30-inch maple tree; copper nail and washer, tree marked "U. S. B. M. 3,533.5".......... 3,533.85

Osceola, 1.35 miles northwest of, 500 feet northwest of **Osceola School,** 50 feet east of road center, north side of low gap, in top of flat boulder; bronze tablet stamped "3595 W. Va. 1921 H 103"........................... 3,595.091

From Durbin Quadrangle southeast across southwest corner of quadrangle into Hightown Quadrangle.

Bartow, 2.08 miles southeast of, on north edge of road, on top of ledge of rock; chiseled square, telephone-pole marked "U. S. B. M. 3,523.7"........................... 3,523.66

	Feet.
Bartow, 3.95 miles southeast of. 40 feet west of road center, in saddle of road, set in top of concrete post; bronze tablet stamped "3625 W. Va. 1921 H 128", telephone-pole marked "U. S. B. M. 3,624.7"	3,624.617
Witness bench mark, 40.2 feet south of tablet, in west root of 12-inch oak tree; copper nail and washer	3,624.59
Bartow, 4.81 miles southeast of, on west edge of road, at foot of hill, across road from house, in west root of 20-inch sugar tree; copper nail and washer, telephone-pole marked "U. S. B. M. 3,696.5"	3,696.41
Bartow, 5.4 miles southeast of. in sharp turn in road, 30 feet north of lane, in east root of 12-inch oak tree; copper nail and washer, mail-box-post marked "U. S. B. M. 3,906.8"	3,906.67

Primary leveling by R. C. Seitz in 1922:

(A checked line).

From Circleville Quadrangle, west up trail to summit of Spruce Knob.

Circleville, 1.50 miles west of, at forks of road, on north side of Bouses Run; chiseled mark on rock at south edge of road	2,596.65
Circleville, 2.1 miles west of, about 0.25 mile below Howard Bennett's house, at sharp bend in road, north edge of road, 2 feet west of 6-inch hickory tree on rock; chiseled square	3,014.34
Circleville, 2.5 miles west of, at edge of clearing on brow of spur, in root of 18-inch locust tree; copper nail and washer	3,527.85
Circleville, 3 miles west of, in root of oak tree, 12 feet north of trail; nail	3,796.19
Circleville, 3.01 miles west of, in root of ash tree, 10 feet west of trail; nail	3,904.67
Circleville, 3.25 miles west of, in root of beech tree; copper nail	4,294.61
Spruce Mountain triangulation station and Fire Lookout, on highest part of and near south end of **Spruce Mountain**; bronze tablet set in rock, 10 feet south of southeast corner of Lookout, stamped "4860"	4,860.115
Witness bench mark, on large rock to which guy wire from northeast corner of Lookout is attached, 35 feet north-northeast of bench mark; chiseled square	4,860.63

INDEX.

A

Page.

Abrasion Tests....................300
Abrasives 70
Absorption Tests..................300
Acreage in Farms...................17
Acreage of Improved Land in Farms..17
Acts of Virginia General Assembly..8, 9
Ada Shale..................196, 205
Adams, Miss M. W..................272
Adamson, J. R.....................344
Agglomerate 267
Air-Line Distance (Streams)......42-43
Alderson Limestone...........188, **189**
Alexander, C. K...................328
Allegheny Front..................
1, 10, 24, 29, 37, **38**, 50, 51, **208**, **209**, 240, 243
Allegheny Mountains ....
......1, 23, 27, 29, 37, **38**, 50, 180
Allegheny Series..................281
Alluvial Cones..............220, 252
Alluvial Flood-Plain Deposits..218, 305
Alluvium (Qal)..........213-218, 307
Alpena 333
Alt, Joe..........................346
Alt School........154, 164, 254, 348
American Institute of Mining and Metallurgical Engineers..............285
Amount Water Used.................304
Analcite (Zeolites of)............267
Analyses and Collections, List..314-316
Analyses:
Calcareous Sandstone.......297, 300
Chert 297, 298
Clinton Iron Ore...............278
Coal (Mauch Chunk)............284
Gravel, Chert, and Clay.....297, 298
Limestone 290-2, 297
Manganese 281, 314
Oriskany Iron Ores..........279-280
Road Materials..........297-9, 301
Sandstone ..278, 297, 298, 299, 314
Shale 298, 299, 301
Analysis, Chemical, of Volcanic Breccia
.... 271-3
Analysis, Optical, of Volcanic Breccia 271
Andesine 267, 270, 273
Andesine, Basic...................271
Andesite-like Rock................271
Andesitic-Breccia 271
Animals (Mammals) and Birds on Spruce Mountain, List of (by Brooks)
.... 310
Anticlinal Area, Elkhorn Mountain-Long Ridge **235-6**, 242, 243, 244
Anticlinal Area, Wills Mountain....237-8
Anticlinal Areas................231-2
Anticlinal Mountains.........232, 241
Anticlinal Valleys................232
Anticline:
Cave Mountain..................237
Elkhorn Mountain...............236
Hopeville 238
Horton 240
Jack Mountain..................236
Long Ridge.....................236
Stone Mountain.................236
Sweedlin Hill 235
Whip Cove 235
Wills Mountain...............237-8
Anticline, Definition.........227, 232
Anticlines 61, 62, 67
Anticlinorium 228

Page.

Apatite 267, 270, 271, 272
Appalachian Area 228
Appalachian Folds.................228
Appalachian Geosyncline 228
Appalachian Mountain and Plateau Province 305
Appalachian Mountains 228
Appalachian Plateau 24
Appalachian Valley.................24
Appendix—Levels Above Mean Tide...
.... 317-358
Apportionment of Road Funds......4, 5
Arch 229, 230, 232
Area 9-10, 16
Area, Farm.........................17
Area of Outcrop, Stones River Limestone 80
Areal Distribution, Martinsburg Shale..74
Areal Distribution, White Medina..61-67
Areas, Cut-Over Forest............308
Areas, Drainage..........43-4, 58, 59
Areas, Drainage Basins............43-4
Areas, National Forests............14
Areas, Virgin Forest..............308
Assessments 18
Augite 267
Augusta County, Va. (Northern Corner) 29
Automobiles 3
Available Streams (Water-Power)..55-59
Avis (Hinton) Limestone..........
...............199, 286, 291, 292
Axis (of Anticline or Syncline).....227

B

Back Ridge School.................265
Back Run...........................52
Bald Knob 29
Baltimore & Ohio R. R.......2, 3, 274
Baltimore & Ohio R. R., Levels....346-7
Barley 17
Bartow 356, 357, 358
Base-Leveling 27, 29, 30
Basic Process (Iron Ores).........279
Basins, Drainage 40-52
Basins, Drainage, Areas..........43-44
Basins, Drainage, Description.....44-52
Bass P. O.........................350
Bassler and Ulrich................111
Beckett Sand......................180
Becraft Member (Absent)......132, 133
Bedding-Planes 303
Beef Cattle 17
Bemis 328, 329, 336, 337
Bemis-Glady Road..................337
Bench, Definition.................227
Bench Marks...................317-318
Bennett Gap 180
Bennett, Howard...................358
Bennett, Robert...................320
Berea Sand.................180, 181
Bergdall, J. Ed...................347
Bertha Sandstone....193, 194, 196, 197
Bessemer Steel (Iron Ores)....279, 280
Bethel District:
Area 9
Assessments 18
Population 16
Post-Offices 19
Bethlehem Church............162, 327
Beulah 337
Beveling 30

Page.
Bible Knob 142, 277
Bible Knob, Iron Ore 277, 278
Bible Knob, Manganese 280, 281
Bickett Shale 196
Big Injun Sand 180, 181
Big Mountain ....
40, 62, 139, 142, 175, 231, 233, 237, 241, 243
Big Run ....
42, 43, 44, **50-2**, 52, 58, 175, 176, 265, 344, 353
Big Run Church Yard 353
Big Spring 345
Biotite 267, 270, 271, 272, 273
Birds and Animals (Mammals) on Spruce Mountain, List of (by Brooks) 311
Blacksmithing (Iron Ores) 279
Blackthorn Creek .. 42, 43, 44, **47**, 339
Blizzard Run 42, 43
Bloomsburg Sandstone and Shale ......
108, 113, 117, 119, 120, **120-4**, 124, 126, 247, 248
Bloomsburg Sandstone and Shale:
East of North Fork Mountain ... 120-3
Locations (Fossil) 123-4
Near Fault-Line in Smoke Hole (Plate XXXIII) 121
One Mile E. of Kline P. O. (Plate XXXIV) 122
Paleontology 123-4
Thickness 120
West of North Fork Mountain 120
Bluefield Group 195-7, 197
Blue-Grass 81
"Bluehole" 138
Blue Rock School 350
Blue Rock Syncline ....
.... 237, 241, 243, 244, 247
Bluestone Group **195**, 202, **283**, 284
Bobs Mountain ....
40, 62, 70, 105, 108, 237, 247, 287
Bobs Mountain Anticline 70
Boggs, Gardner 341
Boggs Mill 52
Boggs, P. 300
Boggs, William, Iron Ore Prospect and Analysis 279
Boiling Impure Water 304
Borror School 143, 150, 162, 350
Bossardville Limestone ....
84, 116, 120, 123, 124, 125, 126, **126-32**, 136, 247, 248, 249, 250, 255, 258, 259, 266, 272, 286, **289**, **290**, **291**, 302, 306
Bossardville Limestone:
East of North Fork Mountain ... 126-7
Locations (Fossil) 130-2
Map Showing (Figure 20) 115
Paleontology 130-2
Plates XXXV and XXXVI 128-9
Thickness 120, 289
West of North Fork Mountain 126
Boulders 35
Boulders, Present River Gravels and . 218
Boundaries 1-2, 8
Boundaries, Changes in 9
Bouses Run **304**, 358
Bowden 328, 332, 333, 334
Bower, M T 327
Bowers, D. F. 300
Bowman Bros. and Dr. Dyer (Brick Clay) 293
Bowman Iron Ore Prospect, Iron Knob 275, 278
Brady Gap Run 47, 149
Branch 19
Brandywine ....
11, 12, 13, 19, 21, 49, 52, 151, 162, **163**, 165, 168, 172, 176, 181, **183**, 223, 259, 297, 323, 328
Brandywine-Franklin Road . 297, 298, 301
Brandywine, Precipitation at 11
Brandywine, Snowfall at 12
Brandywine, Temperature at 13
Breadth of County 1
Breccia, Volcanic 294
Breccia, Volcanic, Igneous Dike of (Chapter VI) 266-273
Brick Material 293
Bridgewater, Va. (Brick Plant) 293
Briery Gap Run 42, 43, 320
Briery Gap School 320
Briggs Run **42**, **44**
Broad 19
Broad Run 43, 44, **49**
Broad Run (of Brushy Fork) 49
Brooklyn School 324
Brooks, A. B. 308, 310
Bruner Mountain 356
Brushy Fork 43, 44, **49**, 153, 168
Brushy Fork Church 168
Brushy Fork School 49
Brushy Knob 142
Brushy Mountain ....
.... 62, 70, 74, 81, 243, 279
Brushy Mountain, Iron Ore Analysis .. 279
Brushy Run P. O. 340
Brushy Run School 206, 286
Brushy Run (Stream) ....
42, 43, **50**, 54, 167, 189, 191, 219, 253, 286, 303
Brushy Run (Stream) (of Mill Creek)
.... 42, 44, **45-6**
Brushy Run (Town) ....
19, 21, 46, 156, 169, 172, 334, 345
Brushy-Simmons Mountain Section (Figure 9) 82
Bucklick Run 48
Buckwheat 17
Buffalo Hills 40
Buffalo Run 47, 149
Building Stone 73
Bull Pasture Mountain (Igneous Dike)
.... 266-273, 294
Bull Pasture Mountain, Views (Plates LXXV and LXXVI) 268, 269
Bullpasture Mountain .. 39, 268, 269, 294
Burning Lime (Plate XXXVI) 129
Burros 17
Byrd Mill 52

C

Cacapon Sandstone 105
Calcareous Sandstone, Analyses 297, 300
Calcite 267, 270, 273
Calcite Bed 80, 87, 101
Calcite Crystals 132, 256
Calcite Infiltration 250
Calcite Veins 118, 119
Calhoun, H. M. 18, 21, 22, 296
Calhoun, H. M. (Building) 295, 296
Callahan, J. Morton 57
Camp Run 43, 44, 48, 165, 173, 352
Camp Run Road 327, 352
Camp Site, Thorn Creek ("Reunion Grounds") (Plate VI) 33
Carbon Ratio of Coals 284-5
Carbon Ratios of Coal in W. Va. Oil Fields 285
Carbonaceous Material, Black 283
Carboniferous Rocks 23, 178, **179**
Carboniferous Rocks (Fig. 24), Map Showing 179

Page.
Carboniferous Sandstone............87
Carr School....................342
Castle Knob....................118
Castle Mountain..................
40, 47, 62, 67, 69, 107, 118, 231, 237, 245, 247, 248, 249, 262, 264, 287
Castle Mountain Anticline.......70, 71
Castle Mountain Section (Fig. 13)..84
Casts and Impressions of Logs......169
Cathedral Arch of Seneca Rocks (Plate XIV) 65
Caton Hollow 325
Catskill-Chemung Contact..........174
Catskill-Pocono Contact...........177
Catskill Sandstones...............294
Catskill Series..................
29, 133, 159, 171, 174, **174-7**, 178, 183, 184, 283
Catskill Series:
East of North Fork Mountain....176-7
Map Symbol (Dck)............174
Paleontology 177
Thickness 159, 172, 176, 177
West of North Fork Mountain...174-6
Catskill Shale and Sandstone........
24, 38, 39, 166, 168, 180, 183, 243, 259, 264, 265, 306
Cattle, Beef and Dairy............17
Caution Regarding Water........303-4
Cave 19, 52, 258, 302
Cave Mountain....................
40, 62, 136, 140, 142, 144, 223, 231, 233, 237, 244, 247, 255, 256, 302
Cave Mountain Anticline..**237**, 241, 247
Cave P. O.....320, 322, 323, 324, 354
Cave School....78, 250, 258, 302, 322
Cave School Area, Faulting in the..250
Caverns 87
Caves ....
54, 136, 140, **223**, 255-6, 257, 258, 301
Cement, Limestone Suitable for......
........78, 79, 80, 286, 289, 296
Cementing Materials (Sandstone)....293
Census, United States..........16, 17
Central W. Va. & Southern R. R.......2
Central W. Va. & Southern R. R., Levels
....................329-30, 330-1
Chambersburg Limestone............
77, 78, 78-9, 81, 82, 86, 87, 89, 103, 262
Chambersburg Limestone:
Economic Character..............79
Faunal Character................79
General Character...............78
Map Symbol (Ocb)..............78
Outcrop 78
Thickness 78-9
Chance (Little) for Oil and Gas....284
Channels, Dry..................301, 302
Channels, Underground............
46, 55, 56, 127, 136, 256, 258, 301, 302, 303
Chapter I—Historical and Industrial Development 1-22
Chapter II—Physiography and Water-Power 23-59
Chapter III—Rocks Below the Clinton
.... 60-103
Chapter IV—Geological Formations Above the White Medina....104-226
Chapter V—The Geologic Structure...
.... 227-265
Chapter VI—Igneous Dike of Altered and Extremely Weathered Volcanic Breccia 266-273
Page.
Chapter VII—Economic Geology.274-316
Character, Economic:
Chambersburg Limestone..........79
Gray Medina 73
Martinsburg Shale...............78
Red Medina 72
Stones River Limestone..........80
White Medina 70
Character, Faunal:
Chambersburg Limestone 79
Character, General:
Chambersburg Limestone 78
Gray Medina 72-73
Martinsburg Shale 75-76
Red Medina 70-71
White Medina 67-69
Cheat River 25, 329, 337
Cheat River Divide (Plate LI).....207
Chemical Analysis, Dikes.........271-3
Chemung-Catskill Contact..........174
Chemung Limestone.....167, 286, 287
Chemung-Portage Contact..169-71, 173
Chemung Sandstones.........242, 294
Chemung Series ....
29, 133 149, 159, 162, 166, 167, 168, 171, **171-4**, 175, 259, 264, 265, 283
Chemung Series:
East of North Fork Mountain....172-3
Location (Fossil) 173-4
Map Symbol (Dch)............171
Paleontology 173-4
Thickness 159, 171, 172, 173
West of North Fork Mountain...171-2
Chemung Shale 24
Chert ....
..133, 140, 255, 287, 297, 298, 306
Chert ....
(See New Scotland and Shriver Cherts)
Chert Analyses 297, 298
Chesapeake & Ohio R. R.........2, 3
Chestnut Trees 81
Chestnut Woods 237
Chimney Rock 39
Chlorinization 304
Chlorite 267
Circleville ....
19, 21, 52, 69, 71, 73, 76, 77, 106, 116, 127, 219, 248, 250, 262, 264, 265, 286, 300, 302, 304, 319, 320, 353, 358
Circleville District:
Area 9
Assessments 18
Population 16
Post-Offices 19
Circleville Gap ....
......86, 88, 90, 91, 104, 120, 126
Circleville Gap Section (Figure 18)
.... 85
Circleville Gap Section (Red Medina) (Figure 19)..................85
Circleville Quadrangle ....
317, 319, 327, 338, 341, 345, 353, 358
Circleville Quadrangle, Levels...319-326
Circleville, Water-Supply 304
Civil War 223
Class "A" Roads 5
Classification (Levels) 317
Clay 306, 307
Clay Analyses...............297, 298
Clay and Shale 292-3
Clay, Sandy 306
Clays, Terrace and River Valley......
..................213, 220, 223
Climate 10-13

Page.
Climatological Data 11-13
Clinton Iron Ores......274-9, 280, 315
Clinton Iron Ores:
Analyses 278-9
Map 276
Outcrops 275, 277
Prospects 275
Quantity 277-8
Thickness 275
Clinton Limestone 286, 287
Clinton, Lower 111
Clinton-Medina Contact 105
Clinton, Middle 111
Clinton-Niagara Contact...........105
Clinton, Rocks Below the (Chapter III) 60-103
Clinton Sandstone ..275, **278**, 294, 315
Clinton Sandstone, Analysis........278
Clinton Series 24, 61, 62, 69, 82, 83, 84, 85, **105-114**, 117, 118, 126, 247, 248, 249, 250, 258, 262, 264, **274-9**
Clinton Series:
East of North Fork Mountain...107-9
General Section 105-6
Locations (Fossil)..........112-114
Map Symbol (Scl) 105
Paleontology 109-114
West of North Fork Mountain...106-7
Clinton, Upper 111, 113
Close to River Knobs (Faulting)...250
Coal 194, 195, 197, 202, 205, 206, **281-5**
Coal, Analyses (Cmc)........284, 315
Coal, Carbon Ratio...............284
Coal, Fire Creek.................206
Coal, Hunt 202
Coal, Oil, and Gas, With Reference to 281-5
Coal, Pipestem 202, 284
Coal, Section (Cmc) 283
Coarse Sand......................307
Coeymans Limestone 133, 134, 136, 137, 138, 140, **290, 291**
Cold Spring Run..................52
Colic Mountain 40, 231, 237, 243, 259
Collections and Analyses, List..314-316
Collections, Fossil, List.......314-315
Colluvial Soil...................305
Color of Sandstones 293, 294
Color of Shales..................292
Columbia University, Contributions from Geological Department 272
Compressed Anticlines and Synclines 228
Concretions 154
Conditions, Forest 308-313
Conditions, Forest, Original........308
Conditions, Forest, Present......308-10
Conemaugh Series 281
Conglomerates 294
Conifers 308, 310
Connections, Railroad 2-3
Connoquenessing Sandstone, Lower...206
Connoquenessing Sandstone, Upper...206
Construction, Type (Road)........300
Contact Between Folded Rocks and Terrace and River Deposits..213-218
Contact, Catskill-Pocono 177
Contact, Chemung-Catskill 174
Contact, Clinton-Niagara 114
Contact, Genesee-Portage 166-7
Contact, Gray Medina and Martinsburg Shales (Plate XVIII) 90
Contact, Greenbrier-Mauch Chunk...192
Contact, Hamilton-Genesee 160, 166
Contact, Helderberg-Oriskany 141
Contact, Marcellus-Hamilton........154
Contact, Mauch Chunk-Pottsville....205
Contact, Medina-Clinton...........105
Contact, Niagara-Salina............119
Contact, Oriskany-Marcellus 146-7
Contact, Pocono-Greenbrier 186
Contact, Portage-Chemung ..169-71, 173
Contact, Red and Gray Medina (Plate XVI) 88
Contact, Salina-Helderberg 132
Contacts, Gray Medina.............73
Contacts, Martinsburg Shale 77-78
Contacts, Red Medina 71-72
Contacts, White Medina 69-70
Conveyance Through Smoke Hole ..254
Core, Earl L. 311
Core, Earl L. (Article by)....311-313
Corn 17, 307
Correlation, Questions of (Pocono) 183-4
Corundum 267, 270, 271
Cost of Roads 4-8
County Clerk 17, 18
County-District Road Work..........4
County Farm, View North Toward Upper Tract (Plate VII)........34
County Financial Data (Roads)......4
County Road Levy 4
Cow Knob 168
Cowger, C. 349
Cowger Mill 52, 327
Cowpasture River 39
Crabbottom Road 354
Cracks in Limestone 302
Creek 19
Cretaceous Time 23
Crevices (Limestone) 188, 258, 262, 302
Cross-Bedding 180, 184
Cross-Section A—A'............... ....231, 240, **241-2**, 242
Cross-Section B—B'....231, 240, **242-3**
Cross-Section C—C'....231, 241, **243-4**
Cross-Section D—D'..241, **244**, **247**, 257
Cross-Section E—E'......241, **247-250**
Cross-Sections.........**240-4**, 244, 247
Cross-Sections (Figures 7 to 19)..82-85
Crummet Church........155, 158, 303
Crummet Run 166
Crushing 231
Crystalline Rocks (None).........294
Cut-Over Forest Areas 308
Cypress Division (Cgr)............188
Cypress Sandstone 190
Cypress Shale 187, 188, **189**, **192**

D

Dahmer 19, 61, 113, 119, 275, 278, 291
Dahmer, Iron Ore Analysis........278
Daily Mail Service..............18-19
Dairy Cattle 17
Dam Sites, Proposed........55, 56, 57
Dams 304, 305
Darton, N. H................266, 274
Dasher, George 353
Dasher, J. 349
Data on Federal Aid Projects (Roads)..6
Data on State Aid Projects (Roads)...5
Data on State Projects (Roads).....6-8
Data, Road 4-8
Data, Stream..................40-43
Data, Stream (Table)...........42-43
Datum (Levels) 317
Davis, Fred A....................297
Davis Quadrangle 343
Davis, W M......................27
Days Mills (Harperton P. O.)......344
Dayton, R. B.....................297

Page.
Deep Spring Syncline.......235-6, 242
Deer Run........42, 44, **46**, 124, 164
Deerrun (P. O.)...............19, 46
Deer Run School..................61
DeKalb Series (Soils).........306, 307
Department of Botany, W. Va. University 311
Description, General 8-20
Description of Drainage Basins....44-52
Descriptions of Plates (Prouty's) (XVI to XXXI) 86-87
Development, Historical and Industrial (Chapter I) 1-22
Development, Present, Water-Power.. 52-55
Devils Backbone 81
Devonian, Lower 133, **133-147**
Devonian, Lower, Map (Figure 21).135
Devonian, Lower, Section (Oak Flat)..133
Devonian, Middle 133, **147-159**
Devonian, Middle, Map (Figure 22).148
Devonian, Middle, Section.........147
Devonian Shales 24, 49
Devonian (Strata) 241, 242
Devonian System 132-177
Devonian, Upper 133, **159-177**
Devonian, Upper, Map (Figure 23)..161
Devonian, Upper, Section......159-160
Diabase 266
Dice Property 300
Dice Run 43, 44
Dickinson Mountain 39, 116, 243
Dickinson Mountain School.......... ....109, 110, 275, 278
Dickinson Mountain School, Iron Ore Analysis 278
Dickinson, W., Iron Ore Analysis....279
Dike, Glenwood, N. Y............272-3
Dike, Igneous 23
Dike, Igneous, of Altered and Extremely Weathered Volcanic Breccia (Chapter VI) 266-273
Dike, Igneous (Views)........268 269
Dike, Mica Peridotite, at Dixonville, Pa. 272, 273
Dike, Peridotite, in Coal Measures, Southwestern Pennsylvania (Gates, Pa.) 272
Diopside 272
Dip (Slope) 227
Discharge of Streams (Second-Feet).. ....58, 59
Disconformity 105, 114, 119, 132, 141, 147, 177, 181, 183, 186, 188, 192, 205
Discussion (Igneous Dike)......267-271
Displacement 247, 249, 250
Dissection 23, 25, 37, 38
Distance, Total and Air-Line (Streams) 42-43
Distribution, Areal, Martinsburg Shale 74
Distribution, Areal, White Medina.61-67
Distribution, Gray Medina...........72
District-County Road Work..........4
Divisions, Greenbrier Series........187
Divisions, Martinsburg Shale......76-77
Doe Hill 47
Doe Hill (Dike) 266
Doe Hill-Johnstown Road..........339
Dolly, Amos 343
Dolly, E. W..................17, 18
Dolly Mill 52
Dolly Trail 262
Dolly Trail, View from (Plate LXVIII) 234
Dolly, Wilbur 19, 21

Page.
Dolomite 273
Domestic Purposes, Water for 301-5
Dorcas 348
Dorcas P. O....................348
Dorcas School 348
Double Mountain 184
Dove, John 352
Dove Mills 52
Dove Triangulation Station 352
Doveville Road 351
Down Into Smoke Hole (Trip)....254-7
Downwarped (Anticlines and Synclines) 227
Drainage Areas 43-4, 58, 59
Drainage Basins 40-52
Drainage Basins, Areas...........43-44
Drainage Basins, Description......44-52
Drainage System, Map Showing (Figure 4) .... .41
Droop Sandstone 193, 194, 196, 197
Dry Channels 301, 302
Dry Fork 329, 330, 331
Dry Hollow 255
Dry Run 42, 44, 47, 107, 116, 126, 143, 219, 254, 258, 286, 291, 302, 354
Dryrun (P. O.) 19
Dry Run Gap 104
Dry Run P. O...............353, 354
Dug Knob 168
Dunning-Wills Mountain Anticline...238
Durbin Quadrangle...........356, 357
Durgon Station..................347
Dyer, Dr., and Bowman Bros. (Brick Clay) 293

E

East Dry Run ..43, 44, 70, 74, 108, 322
East Fork of Glady Creek..........336
East from Franklin (Trip).......258-9
East of North Fork Mountain:
Bloomsburg 120-3
Bossardville 126-7
Catskill Series 176-7
Chemung Series 172-3
Clinton Series 107-9
Genesee Series 162
Greenbrier Series 191
Hamilton Series 154-5
Helderberg Series 134
Limestone 287-9
Marcellus Series 149
Niagara Series 116
Oriskany Series 142-3
Pleistocene and Recent System 219-223
Pocono Series 181-3
Portage Series 167-8
Rondout 124
Salina Series......120-3, 124, 126-7
Economic Character:
Chambersburg Limestone..........79
Gray Medina 73
Martinsburg Shale 78
Red Medina 72
Stones River Limestone 80
White Medina 70
Economic Geology (Chapter VII) 274-316
Eden Division of Martinsburg, Section (Figure 16) 85
Eden Formation 76, 77, 85
Edwards and Moore.. 274
Egypt School 326
Electric Plant, Franklin............55
Elevations by Counties:
Grant 340-346, 346-353
Hardy 346-353

Page.

Elevations by Counties:
- Pendleton ....
  319-326, 326-8, 328-337, 338-9, 340-46, 346-53, 353-8
- Pocahontas 353-8
- Randolph 328-37, 340-46, 353-8
- Tucker 328-37, 340-46

Elevations by Quadrangles:
- Circleville 319-326
- Fort Seybert 326-8
- Horton 328-37
- McDowell 338-9
- Onego 340-46
- Petersburg 346-53
- Spruce Knob 353-8

Elevations (Towns, etc.):
- Alpena 333
- Alt Schoolhouse 348
- Bartow 357, 358
- Bass P. O. 350
- Bemis 329, 337
- Bethlehem Church 327
- Beulah 337
- Big Run Church Yard 353
- Big Spring 345
- Blue Rock School 350
- Borror School 350
- Bowden 328, 333, 334
- Brandywine 11, 12, 13, 323, 328
- Briery Gap School 320
- Brooklyn School 324
- Bruner Mountain 356
- Brushy Run 334, 345
- Brushy Run P. O. 340
- Carr School 342
- Caton Hollow 325
- Cave P. O. 322, 323, 324, 354
- Cave School 322
- Chimney Rock 39
- Circleville 320, 353, 358
- Cowger Mill 327
- Dorcas 348
- Dorcas P. O. 348
- Dorcas School 348
- Dove Triangulation Station 352
- Dry Run P. O. 353, 354
- Durgon Station 347
- Egypt School 326
- Evenwood 332, 333, 334, 335
- Flannigan School 333
- Flint 334
- Fort Seybert 326, 327
- Franklin 321, 322
- Gandy Station 331
- Gladwin 330, 335, 336
- Glady 336, 337
- Glady School 337
- Glady Station 331
- Green Knob 201
- Harman 329, 330
- Harmon Rocks 39
- Harper 323
- Harper Mill 319
- Harper School 323, 325
- Harperton P. O. 344
- Hazelwood (Flag-Station) 330
- Hedricks Chapel 348
- High Knob 39
- Hopeville 343, 346
- Hopeville Gap 343
- Hopeville School 343
- Horton 331, 332, 354, 355
- Jenningston 329, 330
- Job 330, 331, 332
- Johnstown (Moyers P. O.) 325
- Judy Bridge (Moyer Gap) .322, 324, 325
- Judy School 350

Elevations (Towns, etc.):
- Keeter School (Little Italy) 331
- Kile Knob 37, 39
- Kline 325, 350, 351
- Kline Crossroads 351
- Kyle School 340
- Landes P. O. 348
- Laneville 345
- Little Italy (Keeter School) 331
- Lone Oak School 339
- Lone Poplar School 323
- Long Hollow School 343
- Macksville 342
- Meadows 328
- Middle Mountain 336
- Montes 329, 334
- Moorefield 346
- Mt. Olive Church 322
- Mt. Pleasant School 352
- Mt. Pleasant U. B. Church 342
- Mouth of Seneca 342, 343
- Mouth of Seneca P. O. 344
- Moyer Gap (Judy Bridge) ....
  322, 324, 325
- Moyers P. O. (Johnstown) 325
- McCoys Mill 322
- New Bethel Church 327
- New Hopeville 343, 345
- Oak Flat 327, 328
- Oak Grove 321
- Onego 344
- Osceola 336, 355, 357
- Osceola School 357
- Palo Alto, Va. 338, 339
- Pansy P. O. 347, 348
- Peru 349, 350, 351, 352
- Petersburg 346, 347, 348
- Petersburg Gap 347
- Pine Knob 352
- Pleasant Grove Church 327
- Red Creek Junction 329, 330, 344, 345
- Riverton 319, 320, 341, 342
- Roaring Plains 209
- Rough Run School 349, 350
- Ruddle 320, 321, 346
- Ruddle P. O. 320, 321
- Scherr 343
- Schmucker School 351
- Sinnet School 325, 326, 339
- South Branch at Pendleton-Grant Line 10
- South Fork Road 327, 352
- Spring Brook 346
- Spruce Knob ....
  .... 10, 38, 310, 238, 242, 358
- Spruce Mountain Triangulation Station and Fire Lookout 358
- Stark School 357
- Sugar Grove 323, 324, 325, 338
- Thornwood 356, 357
- Upper Tract ....
  .... 11, 13, 319, 340, 341, 351
- Upper Tract P. O. 340, 346
- Virginia and W. Va. State Line ....
  .... 327, 352
- Weese 334
- W. Va. and Virginia State Line ....
  .... 327, 352
- White 332
- Whitmer 331
- Wilfong School 338
- Wine Spring School ....
  .... 327, 349, 352, 353
- Woodrow 329, 334
- Wymer 332
- Zion Church 349

Elevations, Highest and Lowest 10

Page.
Elevations, Railroad:
Baltimore & Ohio 346-7
Central W. Va. & Southern.......
.... 329-30, 330-32
Lumber R. R. (Evenwood to Gladwin) 334-6
Western Maryland..328-9, 333-4, 337
Elk Run 52
Elk Series (Soils) 307
Elkhorn Mountain 39
Elkhorn Mountain Anticlinal Area 228
Elkhorn Mountain Anticline........236
Elkhorn Mountain-Long Ridge Anticlinal Area....**235-6**, 242, 243, 244
Elkins-Franklin Road 297, 298
Elkins Quadrangle 337
Elkins Tract, Iron Ore Analysis....279
Elklick Run 50, 187, 193, 194, 203
Engine, Lumber, Used on Seneca Creek (Plate LXXX) 309
Entrance to Trout Cave.......223, 225
Entry Mountain.............142, 236
Erosion ....
29, 186, 213, 232, 241, 242, 281, 305
Error, Limit (Levels)............317
Estate, Real, Valuation............18
Estimate of Quantity of Clinton Iron Ore 277-8
Evenwood 332, 333, 334, 335
Evenwood-Glady Road........336, 337
Evergreen Church............56, 142

F

Fall of Streams..........42-43, 58, 59
Fall of Streams, Rate per Mile....42-43
Fame 19
Farms, Improved Land in..........17
Farms, Land in..................17
Faulting ....
23, 27, 62, 78, 79, **80**, 245, 246, 248
Faulting Close to River Knobs......250
Faulting in the Cave School Area...250
Faults ....
80, 82, 84, 86, 87, 89, 101, 102, 107, 118, 121, 238, 241, **244-250**, 302
Faults, Low-Angle........80, 238, 250
Faunal Character, Chambersburg Limestone 79
Features, Present Topographic.....37-40
Features, Topographic 232
Federal Aid Projects, Data on (Roads)
.... 6
Federal Aid (Road Funds Apportioned) 4, 5
Feldspar (Laths) 267, 270, 271
Feldspars, Plagioclase 273
Ferns, Spruce Knob...............313
Figure 1—Outline Map of West Virginia Showing Progress of Detailed County Surveys.................XX
Figure 2—Outline Map of West Virginia Showing Pendleton County Area XX
Figure 3.—Map Showing National Forests 15
Figure 4.—Map Showing Drainage System 41
Figure 5.—Map Showing Medina Sandstones 68
Figure 6.—Map Showing Ordovician Rocks 75
Figure 7.—Section through Central Portion of Wills Mountain Anticline Showing the Older Limestones and Low-Angle Faults, Near Key, Northeast Portion of Germany Settlement.82
Page.
Figure 8.—Typical Cross-Section Through Wills Mountain Anticline, North Germany Settlement 82
Figure 9.—Section Through Gap Between Simmons Mountain and Brushy Mountain 82
Figure 10.—Hardscrabble Church Section 83
Figure 11.—Profile Section Through Wills Mountain Anticline Along Old Franklin-Circleville Road........ 83
Figure 12.—Profile Section Through Medina-Clinton Ridge, Props Run Road, 2 Miles Southeast of Franklin 83
Figure 13.—Section Through Castle Mountain 84
Figure 14.—Typical Profile Through the Medina Sandstones and the Bordering Shales 84
Figure 15.—Cross-Section Through a Portion of Noah Teter Hollow.....84
Figure 16.—Typical Limestone Lens or Reef in Shales of the Lower Portion of Eden Division of Martinsburg..85
Figure 17.—Riverton Gap Section....85
Figure 18.—Circleville Gap Section ..85
Figure 19.—Typical Section of Portion of Lower-Middle Red Medina, Circleville Gap 85
Figure 20.—Map Showing Silurian Limestones 115
Figure 21.—Map Showing Lower Devonian Rocks 135
Figure 22.—Map Showing Middle Devonian Rocks 148
Figure 23.—Map Showing Upper Devonian Rocks 161
Figure 24.—Map Showing Carboniferous Rocks 179
Figure 25.—Map Showing Iron-Bearing Series 276
Fillers 70
Financial Data, County (Roads)......4
Fine Gravel 307
Fine Sand 307
Fire Creek Coal 206
Fire, Forest 310
Fire Lookout and Cabin on Shenandoah Mountain, East of Sugar Grove (Plate LXXII) 260
Fire Lookout (Spruce Mountain)....358
First Terrace 32, 35
Fisher Run 43, 44
Fisher, Seymour 347
Fishing 257
Fishinghawk Creek 329, 337
Fissures 258, 303
Fixed Carbon Ratios of Coals.....284-5
Flagstone 296
Flannigan School 333
Flesher Run 49
Flint 332, 334
Flood-Plain ....
......32, 34, 35, 36, 167, 251, 253
Flood-Plain, Thorn Creek ("Reunion Grounds") (Plate VI)...........33
Flood-Plain Deposits...............
..........213, 218, 219, 220, 223
Floods 10
Flowering Plants and Grasses, Spruce Knob 313
Folded Rocks and Terrace and River Deposits, Contact Between....213-218
Folding 231
Folds 23
Folds....(See Anticlines and Synclines)
Fore Knobs.................... 262

Page.
Forest Areas, Cut-Over............308
Forest Areas, Virgin..............308
Forest Conditions 308-313
Forest Conditions, Original 308
Forest Conditions, Present......308-10
Forest Fire 310
Forest, Mesophytic, Spruce Knob....312
Forest Service 14
Forests, National 13-15, 308
Forests, National, Map Showing (Figure 3) 15
Formation 8-9
Formations Above the White Medina (Chapter IV) 104-226
Formula for Calculating Carbon Ratio 284
Fort Lewis 39
Fort Seybert ....
19, 21, 49, 52, 123, 124, 143, 223, 326, 327
Fort Seybert Quadrangle............
...........317, 323, 327, 351, 352
Fort Seybert Quadrangle, Levels..326-8
Fossil Collections, List........314-315
Fossil Index:
Actinopteria communis 140
Algae 116, 124, 131, 153
Algal Impressions 112
Allorisma 196
Allorisma clavata ....
....192, 196, 197, 203, 204, 205
Ambocoelia umbonata ....
.........152, 153, 155, 168, 169
Ambocoelia virginiana..157, 158, 159
Amplexus hamiltoniae 159
Anoplotheca acutiplicata 147, 152, 153
Archimedes confertus 192
Archimedes laxus 191
Arthrophycus 119, 123, 124
Atrypa 152
Atrypa reticularis 111, 113
Atrypa spinosa 174
Aulopora tonolowayensis 130, 132
Aviculopecten sp...........157, 204
Bactrites aciculus 164, 165, 166
Balls, Flattened 171
Bellerophon ....
....113, 152, 192, 194, 203, 204
Bellerophon leda 159
Bellerophon marylandicum 111
Bollia 111
Bonnemaia 109, 111, 112, 113
Bonnemaia notha 111
Brachiopods ....
79, 113, 117, 118, 119, 131, 146, 150, 152, 155, 157, 160, 173, 204, 255
Bryozoa 79, 152, 192
Bryozoa, Branching 152
Bryozoa, Ramose 79
Bryozoon-Like Impressions 173
Buchiola 164, 168
Buchiola halli 158
Buchiola retrostriata............
160, 162, 164, 165, 166, 168, 169
Bulimorpha 192
Buthotrephis gracilis ....
.............116, 117, 130, 131
Buthotrephis gracilis var. intermedia
.......................109, 111
Calcareous Pebbles 197
Calymene cresapensis.......111, 112
Calymene sp. 77
Camarotoechia 124, 204, 205
Camarotoechia (?) 196, 202, 203
Camarotoechia andrewsi ....
....112, 116, 117, 118, 119, 128
Page.
Fossil Index:
Camarotoechia litchfieldensis .....
....116, 125, 130, 131, 132, 136
Camarotoechia neglecta 109, 111, 112
Camarotoechia sp. cf. plena......79
Campophyllum gasperense 192
Caryocystites 79
Cephalopods 192
Chasmotopora (cf.) 79
Chonetes coronatus 157, 159, 165
Chonetes mucronatus............158
Chonetes rugosus 152, 153
Cladopora 140
Coelospira hemispherica 111
Coleolus tenuicinctus 159
Composita 191, 204
Composita sp. ? 196
Composita subquadrata ....
....193, 194, 196, 197, 203, 204
Composita trinuclea........191, 192
Corals 79, 152, 153
Conularia undulata 157, 159
Crinoid Fragments 130, 136, 140, 153
Crinoid Stems ....
79, 111, 113, 114, 131, 133, 152, 153, 157, 158, 173, 191, 193, 196, 197, 202, 203, 204, 205
Crustacean Trail 164, 165
Cryptolithus tesselatus 77
Cuneamya ulrichi 118
Cyathophyllum 136
Cyclonema hamiltoniae 157
Cystids 79
Dalmanella multisecta 77
Dalmanella perelegans 140
Dalmanella planiconvexa 140
Dalmanella testudinaria 77
Diaphorostoma 159
Diaphorostoma lineatum (?)......
..................157, 158, 159
Diaphragmus elegans ....
191, 192, 193, 194, 196, 197, 202, 203, 204
Dielasma 203, 204
Dielasma sp. 196
Douvillina cayuta 173
Echinoconchus alternatus ....
.................196, 202, 204
Echinosphaerites aurantium var. americanum 79
Edmondia 196, 203, 205
Eukloedenella 117, 118, 119
Eukloedenella simplex 117, 119
Eumetria costata 191
Euomphalus 174, 192
Favosites 152
Favosites helderbergiae 140
Favosites helderbergiae var. praecedens 136
Favosites pyriformis 136
Fenestella 152, 192, 196, 203
Fenestella cumberlandica 140
Fenestella sp. ?...............140
Fenestella tenax 196, 202, 204
Fragments of Wood and Leaves (Qal) 223
Gastropods ....
......79, 117, 125, 126, 150, 204
Girvanella sp. 79
Gonioceras chaziense .... .79
Grammysia 152
Grammysia subarcuata 165
Griffithides 192, 205
Griffithides sp. 196
Gypidula 140
Gypidula coeymanensis.133, 136, 140
Helicotoma sp. 79

Fossil Index: Page.
Hindella congregata var. pusilla..125
Hindelia congregata var. rotundata.125
Hindella congregata Zone........128
Hindella congregata var. rotundata 125
var. pusilla 130, 131
Hindella (Greenfieldia) congregata
var. rotundata 130, 132
Hindella Zone 248, 249
Hipparionyx proximus 146
Homeospira evax var. marylandica 119
Hormotoma 111, 118, 126, 131
Hormotoma gracilis 77
Hormotoma marylandica..........
............116, 117, 118, 126
Hormotoma sp. 112
Impressions and Casts of Logs 169
Isoteles gigas 77
Kloedenella 117, 118, 119
Kloedenella subovata 119
Kloedenia 125
Leaves and Wood, Fragments (Qal)
.... 223
Leaves, Strap-Shaped ....
.... 159, 181, 183, 186
Leda bellistriata 196, 203, 205
Leperditia 126
Leperditia alta ..118, 119, 125, 130
Leperditia elongata var. willsensis
.... 111, 116, 117, 125, 126
Leperditia fabulites 79
Leperditia mathewsi ...125, 130, 131
Leperditia scalaris var. praecedens
............125, 130, 131, 132
Lepidodendron 188, 191
Leptaena rhomboidalis 116
Leptotrypa 131
Leptotrypa siluriens 130
Lingula ....
130, 158, 164, 165, 177, 202, 204
Lingula nicklesi Zone ....
.............73, 77, 84, 85, 86
Lingula nuda 153
Lingula sp. 157, 158, 159, 196
Liorhynchus limitarc............151
Liorhynchus mysia 151
Logs, Impressions and Casts of..169
Loxonema hamiltoniae......153, 159
Lunulicardium encrinitum 165
Macrochilus hamiltoniae.........157
Martinia contracta 191
Martinia sp. 192, 196, 203, 204
Mastigobolbina...109, 111, 112, 113
Meristella arcuata 140
Modiella pygmaea 157
Modiolopsis 119
Myalina 203, 204
Myalina? 196
Nemataxis fibrosum 152
Nucula bellistriata 158
Nucula lirata (?)..............158
Nucula sp. 159
Nucula varicosa 157
Orbiculoidea 112
Orbiculoidea clarki 109, 114
Orbiculoidea lodiensis var. media.153
Orbignyella wetherbyi 79
Orthoceras..153, 158, 194, 203, 204
Orthoceras cf. exile 157
Orthoceras sp. 79
Orthoceras subulatum 157, 165
Orthoceras transversum 77
Orthoceratites 157
Orthorhynchula linneyi 77, 84, 85, 87
Orthostrophia strophomenoides ...140
Orthotetes kaskaskiensis ....
191, 193, 194, 196, 197, 202, 203,
204

Fossil Index: Page.
Orthotetes keokuk 192, 196, 202, 204
Ostracods ....
79, 109, 111, 112, 113, 119, 124,
130, 140
Palaeoneilo marylandica 157
Palaeoneilo plana 174
Paracardium 164
Paracardium delicatulum 164
Paracardium doris 164
Pelecypods ....
113, 118, 119, 157, 158, 160, 164
Pentremites 191
Pentremites pyramidalis 191
Phacops cristata var. pipa...153, 154
Phacops rana 159
Pharetrella tenebrosa 164, 165
Pholidops hamiltoniae 153
Pholidops sp. 77
Pholidops squamiformis ....
.............109, 111, 112, 114
Pianodema subaequata 79
Plant Fossils 177
Plant Impressions ....
............164, 165, 169, 283
Plant Life 177, 283
Plant-Like Remains 188
Plant Remains ....
169, 177, 178, 181, 182, 183, 186,
195, 205, 213, 283, 293
Plants (Qal) 223
Platyceras marylandicum 174
Platyceras reflexum 141
Platyostoma 159
Plectambonites pisum 79
Plectambonites sericeus 77
Plethobolbina....109, 111, 112, 113
Prasopora simulatrix 77, 86, 90
Productus ovatus ....
191, 192, 193, 194, 196, 197, 202.
203, 204
Proterocrinus menardensis 192
Pterinea 159
Pterinea chemungensis 174
Pterinea emacerata ..111, 112, 113
Pterinea flintstonensis...........118
Pterochaenia fragilis 165
Pterotocrinus 191
Pustula 191, 204
Pustula sp.................. 196
Rafinesquina alternata 77
Rafinesquina cf. minnesotensis.....79
Ramose Bryozoa 79
Rhipidomella hybrida 109, 112
Rhipidomella oblata 140, 141
Rhipidomella vanuxemi 152
Rhynchospira globosa ....
.............125, 130, 131, 132
Rhynchospira sp. 141
Schuchertella prolifica 136
Schuchertella variabilis 152, 153
Schuchertella woolworthana 140
Scolithus 119, 123, 124
Seaweeds 292
Sinuites cancellatus 77
Solenopora compacta 79
Spirifer arenosus ....
.............141, 143, 146, 147
Spirifer consobrinus 157
Spirifer cyclopterus 140
Spirifer disjunctus 173, 174
Spirifer macropleurus ..136, 139, 141
Spirifer mesastrialis 173, 174
Spirifer modestus 136, 140
Spirifer pellaensis ....
192, 193, 194, 196, 202, 203, 204
Spirifer perlamellosus 140

Page.

Fossil Index:
Spirifer vanuxemi 125, 130
Spyroceras nuntium 157
Stems 159, 169
Stereolasma 153
Stereolasma rectum 157
Strap-Shaped Leaves ....
............159, 181, 183, 186
Streptelasma strictum 140
Stromatopora constellata ....
.............130, 132, 136, 140
Stromatopora sp. 140
Stromatoporoid Zone..132, 133, 141
Stropheodonta 111
Stropheodonta arata 140
Stropheodonta corrugata var. pleuristriata 109, 112, 113, 114
Stropheodonta inaequistriata 157
Stropheodonta perplana 157, 158, 159
Strophomena sp. 79
Strophonella leavenworthana 140
Strophonella punctulifera 140
Stumps of Trees 169
Styliolina 126
Styliolina fissurella ....
152, 158, 159, 160, 162, 164, 165, 166
Sulcatopinna missouriensis ....
.... 196, 203, 204
Tentaculites 153, 157
Tentaculites gyracanthus....136, 140
Tentaculites minutus 111, 112
Tetradium cellulosum 79
Tornoceras uniangulare 164, 165, 166
Trail Impressions 164, 165
Trees, Stumps of 169
Trematospira camura 111, 114
Trematospira equistriata 141
Trilobites 111, 112, 150
Tropidoleptus carinatus ....
........154, 155, 157, 158, 160
Twig-Like Forms 171, 174
Twigs 159
Uncinulus 113
Uncinulus nucleolatus 136, 140
Uncinulus obtusiplicatus ....
.................116, 117, 119
Uncinulus stricklandi 111, 113
Whitfieldella marylandica 118
Wood and Leaves, Fragments of (Qal) 223
Worm Impressions (Trail)...164, 165
Worms 124
Yoldia 203, 204
Yoldia? 196
Zaphrentis 153
Zaphrentis spinulosa ....
....193, 196, 197, 202, 203, 204
Zygospira recurvirostris 77, 79
Fossils ....
73, 77, 79, 84, 85, 86, 90, 109, 111, 112, 113, 114, 116, 117, 118, 119, 123, 124, 125, 126, 128, 130, 131, 132, 133, 136, 139, 140, 141, 143, 146, 147, 150, 151, 152, 153, 154, 155, 157, 158, 159, 160, 162, 164, 165, 166, 168, 169, 171, 173, 174, 177, 178, 181, 182, 183, 186, 188, 189, 191, 192, 193, 194, 195, 196, 197, 202, 203, 204, 205, 213, 223, 226, 248, 249, 251, 255, 281, 283, 292
Fractures, Sandstone 303
Franklin ....
19, 20, 21, 47, 52, 55, 61, 62, 69, 70, 108, 120, 124, 127, 137, 141, 142, 143, 146, 149, 150, 153, 154,

Page.

Franklin:
220, 225, 236, 241, 243, 251, 253, 255, 257, 258, 259, 263, 277, 278, 280, 289, 293, 296, 297, 298, 299, 300, 301, 304, 321, 322
Franklin:
Assessments 18
Population 17
Power Plant 52, 55
Road 328
Section (2 Miles S. E.) (Figure 12) 83
Terraces 35, 220
Trout Run Dam 56
View North (Plate II)..........20
View South (Plate V) 31
Water-Supply 304-5
Franklin-Brandywine Road 297, 298, 301
Franklin-Circleville Road ..62, 70, 76
Franklin-Circleville Road (Old), Section (Figure 11) 83
Franklin-Elkins Road 297, 298
Franklin-Harrisonburg Road.........
..................61, 71, 86, 92
Franklin-Monterey Road....3, 298, 299
Franklin-Petersburg Road ....
........3, 162, 167, 172, 242, 296
Franklin, Trips Out From 251-265
Down Into Smoke Hole 254-7
East 258-9
North 251-4
South 257-8
West 259-265
Franklin District:
Area 10
Assessments 18
Population 16
Post-Offices 19
Franklin Folio (No. 32)...........
...............105, 187, 235, 274
Fredonia Beds 186, 187, **189**
Fredonia Limestone 291, 292
French Station (South Branch P. O.)
.... 45
Friends Run ....
42, 44, **47**, 62, 107, 120, 124, 131, 146, 153, 248, 251, 259, 288, 289
Friends Run School ....
118, 123, 126, 128, 131, 259, 262, 288, 289, 291

G

Gabbro 271
Gandy 197, 206
Gandy Creek 330
Gandy Station 330
Gasper Division (Cgr) ....
......187, 188, **189**, **192**, 291, 292
Gas and Oil 285
Gas, Oil, and Coal, With Reference to
.... 281-5
Gates, Pa., Dike 272
Geanticline (Definition) 228
Geist, H. 272
General Character:
Chambersburg Limestone 78
Gray Medina 72-3
Red Medina 70-1
White Medina 67-69
General Description 8-20
General Distribution, Red Medina....70
General Section, Clinton Series ..105-6
General Structure 231-4
Genesee-Hamilton Contact.....160, 166
Genesee-Portage Contact 166-7
Genesee Series ....
133, 149, 151, 152, 153, 155, 158, 160, **160-7**, 167, 168

Page.

Genesee Series:
At Brandywine (Plate XLIII) 163
East of North Fork Mountain....162
Locations (Fossil).............164-6
Map Symbol (Dg) 160
Paleontology 164-6
West of North Fork Mountain...160-2
Genesee Shale ....
24, 160, 163, 167, 220, 242, 254, 259
Geologic Column of Resistant Rocks of County (Plate LXXIX) 295
Geologic Structure (Chapter V) 227-265
Geological Formations Above the Top of the White Medina (Chapter IV) 104-226
Geological Society of America......27
Geology, Economic (Chapter VII) 274-316
Geology (Part II) 60-273
Georges Creek Syncline 240
Geosyncline (Definition) 228
Germany Settlement ....
..........78, 81, 86, 87, 89, 103
Germany Settlement Sections (North) (Figures 7 and 8) 82
Getz, John 352
Gilbert Sandstone, Lower 206
Gilmer County (Schooley Peneplain) 27
Glacial Period 223
Gladwin 329, 330, 334, 335, 336
Glady 336, 337
Glady-Bemis Road 337
Glady-Evenwood Road 336, 337
Glady Creek 336
Glady Fork 333
Glady School 337
Glady Station 331
Glass-Sand 70, 296
Glen Dean Limestone ....
..187, 188, **189**, **191**, 192, 290, 292
Glenray Limestone 196-7, 203-4
Glenray Limestone and Shale..193, 194
Glenray Shale 196
Glenwood, N. Y., Dike 272-3
Goats 17
Good Land 307
Good Roads 3
Goshen Ridge 30
Goshen School ....
47, 107, 117, 118, 125, 241, 247, 249, 250
Gould Mfg. Co..................304
Graeber, Charles K...........272, 273
Graham Sandstone 195
Grains, Mineral (Soil Types), Sizes, etc. 307
Granite (No) 294
Grant County, Levels....340-6, 346-53
Grant County Line, South Branch of Potomac River at 10, 38
Grant-Pendleton County Line..189, 286
Grasses and Flowering Plants, Spruce Knob 313
Grassy Mountain 180, 240
Gravel ....
35, 218, 219, 220, 223, 226, 252, 296, 297, 298
Gravel, Analyses 297, 298
Gravel, Fine 307
Gravel, Sandstone, and Sand......293-6
Gravels, Present River Boulders and.218
Gravels, River 213
Gravity, Specific (Limestone and Sandstone) 300
Gray, B. E. 3

Page.

Gray Medina ....
23, 71, 72, **72-3**, 77, 82, 84, 85, 86, 87, 88, 90, 262, 265
Gray Medina:
Character 72-3
Contacts 73
Distribution 72
Economic Character 73
Map Symbol (Sgm) 72
Thickness 73
Green Knob ..197, **201**, 206, **207**, 264
Greenawalt School....46, 108, 123, 124
Greenbrier Limestone ....
24, 54, 178, 180, 181, 184, 186, 189, 191, 197, 286, 287, **291**, **292**, 301
Greenbrier-Mauch Chunk Contact....192
Greenbrier-Pocono Contact 186
Greenbrier River 25
Greenbrier Series ....
...........177, 178, 179, **187-192**
Greenbrier Series:
East of North Fork Mountain....190
Map Symbol (Cgr)............187
Paleontology 191-2
Section 189
Thickness....24, 177, 187, 188, 189
West of North Fork Mountain.187-90
Greenland Gap Quadrangle....343, 346
Grimsley, Dr. G. P. 274
Grist-Mill 303
Groves 308

H

Hackett Shale 195, 283
Hagerstown Series (Soils) 306
Halloway, William 341
Hamilton-Genesee Contact 160, 166
Hamilton-Marcellus Contact........154
Hamilton Series ....
....133, 147, **154-9**, 160, 166, 167
Hamilton Series:
East of North Fork Mountain....154-5
Locations (Fossil) 155-9
Map Symbol (Dhm) 154
Paleontology 155-9
Thickness 147, 154, 155
West of North Fork Mountain....154
Hamilton Shale ....
24, 35, 149, 150, 152, 153, 154, **156**, 160, 162, 166, 220, 242, 254, 259, 303
Hammer, G. W. 300
Hammer Run ....
42, 43, 44, **46-7**, 70, 127, 129, 130, 149, 291, 321, 322
Hampshire County (Hedges Shale).... .... 183, 184
Hampshire County, Population per Square Mile 16
Hampshire County Report 112
Hampshire Formation 166
Hampshire-Hardy-Mineral County Line (Schooley Peneplain) 27
Hardscrabble Church ....
....61, 69, 70, 71, 86, 92, 108, 258
Hardscrabble Church Section (Figure 10) 83
Hardness Tests 300
Hardwoods 308, 310
Hardy County, Levels 346-53
Hardy County, Population per Square Mile 16
Hardy-Hampshire-Mineral County Line (Schooley Peneplain) 27
Harman 2, 329, 330
Harman, Isaac 350

Page.
Harman, J. C. & Co..............344
Harman Knob 250
Harman, Sarah E. 341
Harmon Rocks ....
........30, 39, 86, 94, 97, 107, 262
Harper 108, 323
Harper Gap.....74, 78, 104, 107, 287
Harper Mill 250, 319
Harper School 124, 323, 325
Harper, Sylvanus 319
Harperton P. O. 329, 344
Harris, E. E. (Photographer)........26
Harris, E. E. (Levelman)..........
319, 327, 330, 338, 345, 353, 354
Harrisburg Peneplain ....
........20, 23, 25, 27, 28, **30-2**, 38
Harrisburg Peneplain, Monadnocks on..27
Harrisburg Peneplain, Valley Cut Below 27
Harrisonburg Road......168, 183, 259
Harrisonburg, Va. 2
Hawes Run 43, 44, **49**, 259
Haystack Knob 193, 197, 200, **211**, 264
Hazelwood (Flag-Station) 330
Heavener, Robert 345
Heavener Run 162
Heavener, Will 342
Hedges Shale 183, 184
Hedricks Chapel 348
Helderberg Limestone ....
130, 143, 149, 242, 243, 247, 250, 251, 252, 255, 257, 258, 259, 264, 266, 272, 286, 289, 296, 302
Helderberg-Oriskany Contact 141
Helderberg-Salina Contact......... 132
Helderberg Series 133, **134-141**
Hematite 188, 267, 277, 279, 292, 294
Hendricks 2
Hendricks Sandstone and Conglomerate
..159, 171, 172, 173, 174, 176, 259
Herbaceous Plants, Spruce Knob..311-12
Hevener Mill 52, 55
High Knob 39
High Rock School ....
......46, 123, 124, 127, 131, 143
High Top..176, 181, 182, 183, 186, 259
High Top Section 182-3
Highest and Lowest Elevations..10, 38
Highest Point in State (Spruce Knob)
.... 210
Highlands, Stony 307
Hightown Quadrangle 357
Highways 3-8
Hiner, B. H. 300
Hinton (Avis) Limestone...........
..............199, 286, 291, 292
Hinton Group..194, **195**, 197, 205, 284
Hinton Group Section (Long Run)..
..................195, 283, 284
Hinton Sandstone (of Stevenson)....
........................194, 195
Hiser 45
Historical and Industrial Development (Chapter I) 1-22
History of Pendleton County.........8
History, Physiography, and Water-Power (Part I)................1-59
Hiveley Gap 258
Hoffman, Henry 345
Hoffman, Luther 344
Hoffman Ridge 191, 197, 240, 264, 286
Holly Series (Soils)..............307
Holston Series (Soils) 307
Honess, Arthur P. 272, 273
Hoover Mill 52
Hopeville 342, 343, 344, 346
Hopeville Anticline 238
Hopeville Gap 343
Hopeville School 50, 343
Hopewell School 78, 262, 287
Horsecamp Run................50, 344
Horse-Power Available from Storage..59
Horse-Power, Indicated, Developed by South Branch of Potomac River....59
Horse-Power, Indicated, Developed by Tributaries of South Branch of Potomac River 58
Horse-Power of Streams, Indicated 57-59
Horses 17
Horton 2, 240, 331, 332, 354, 355
Horton, A. H. 57
Horton Anticline ....
......232, **240**, 241, 242, 243, 264
Horton Quadrangle ..317, 328, 344, 354
Horton Quadrangle, Levels......328-337
Hot Springs, Va. 2, 3
Howe, H. C. 11
Humus 305
Hunt Coal 202
Hunting Ground ....
19, 175, 180, 191, 197, 262, 265, 286, 306
Hunting Ground Mountain..........265
Huntington Series (Soils).........307

I

Ice Sheets 223
Iceland Spar 86
Igneous Dike of Altered and Extremely Weathered Volcanic Breccia (Chapter VI) 266-273
Igneous Dike (Views)........268, 269
Igneous Dikes 23
Igneous Rock 280, 315
Ilmenite 272, 273
Impressions and Casts of Logs......169
Impressions, Plant 169
Improved Land in Farms............17
Increase in Population, Per Cent....16
Indian Trail 211
Indians' Hunting Ground 226
Indicated Horse-Power Developed by South Branch of Potomac River....59
Indicated Horse-Power Developed by Tributaries of South Branch of Potomac River 58
Indicated Horse-Power of Streams..57-59
Industrial and Historical Development (Chapter I) 1-22
Industries and Towns 21-22
Inhabitants per Square Mile 16
Insects 310
Interfingering of Chemung and Catskill
.... 174
Interglacial Times 223
Introduction (Chapter II)........23-24
Introduction (Chapter III).......60-61
Introduction (Chapter IV).......104-5
Iowan Division 188
Iron 266
Iron-Bearing Series, Map Showing (Figure 25) 276
Iron Knob 109, 274, 275, 278
Iron Knob, Iron Ore Analyses......278
Iron, Metallic (Content)....278-9, 280
Iron Ore Prospects 275, 278
Iron Ores ....
106, 107, 108, 109, 146, **274-81**, 315
Iron Ores, Thickness 275
Iron Oxide 294
Iron Pyrites 153
Iron Sandstone 69, 109
Iron Sulphide 303
Isocarb Lines 284-5

Page.
Items, Miscellaneous 8-20
Ithaca, N. Y., Peridotite Dike Near..272

J

Jack Mountain ....
24, 38, 40, 61, 62, 70, 109, 143, 236, 258, 275
Jack Mountain Anticline 61, 62, **236**, 244
James River 25
Jefferson County (Hedges Shale)....184
Jenkins, Ben. 346
Jennings Formation 166
Jenningston 329, 330
Job 330, 331, 332
Job Knob 197, 206
Johannsen, Prof. Albert...........271
Johnston, Ellen 319
Johnstown-Doe Hill Road..........339
Johnstown (Moyers P. O.)......47, 325
Jordan Run 343
Journal of Geology 272
Judy Bridge (Moyer Gap).322, 324, 325
Judy, C. N. 300
Judy Gap 3, 74, 78, 104, 238, 262
Judy, Lige 348
Judy Rocks 264
Judy School 350
Judy Spring (Mill Creek)..........
..42, 43, 78, 81, 87, 262, 292, 302
Jura-Cretaceous Time...........23, 27

K

Kane Creek 143
Kaolin 271, 292
Kaplan, B. B. ....
......271, 272, 278, 281, 284, 290
Kee, J. K. 300
Keefer Sandstone ....
105, 106, 107, 108, 109, 112, 113, 114, 117, 118, 120, 249
Keefer Sandstone (0.3 Mile South of Dickinson Mountain School) (Plate XXXII) 110
Keener Sand 180
Keeter School (Little Italy) 331
Keister, Elmer L. 11, 12, 13
Kemp, J. F. 272
Keplinger, D. R., Lime-Kiln........
.......**126-7**, 130-1, **289**, 290, 291
Keplinger Lime-Kiln (Plate XXXVI).129
Keplinger Quarry, Section 127
Kessner Run 42, 44
Ketterman 67, 254, 255, 257
Ketterman Mill 54, 303
Kettle Creek 43, 44, **48**
Key ....
19, 78, 79, 80, 86, 87, 89, 101, 102, 103, 250
Key Section (Figure 7) 82
Keyser 38
Keyser Limestone ....
132, 133, 134, 136, 140, 289, **290**, **291**, 306
Kile, E. M. 340
Kile Knob 29, 37, 39
Kimball, Ollie 256
Kimble, O. B. 348
Kiser, C. R. 324
Kiser Mill 52
Kittatinny Peneplain 27
Kline..19, 45, 46, 122, 326, 350, 351
Kline Mill 46, 52, **53**, 55
Klines Crossroads 351
Klines Crossroads Mill Gap 350
Knobs 232, 242
Kummel 108
Kyle School...136, 157, 253, 256, 340

L

Page.
Labradorite 267, 270
Lackawaxen Conglomerate 173
Lance, C. 357
Land, Good 307
Land, Improved, in Farms 17
Land in Farms 17
Landes P. O.....................348
Landslide (Run) ....
...........194, 196, 205, **282**, 283
Laneville 345
Lankey Mountain 40, 142, 231, 237, 259
Laths of Feldspar 267
Latitude 1
Laurel Fork 42, 44, 50, **52**, 354
Laurel Hill Church 236
Laurel Hill School (Dike)........266
Laurel Hill School, Iron Ore ..279, 280
Laurel Run 42, 43
Length of County 1
Length of Streams 42-3, 58, 59
Leucoxene 273
Level Land 10
Levels Above Mean Tide—Appendix
.... 317-358
Levels Above Mean Tide..(See Elevations)
Levels by Counties:
Grant 340-6, 346-53
Hardy 346-53
Pendleton ....
319-26, 326-8, 328-37, 338-9, 340-6, 346-53, 353-8
Pocahontas 353-8
Randolph 328-37, 340-6, 353-8
Tucker 328-37, 340-6
Levels by Quadrangles:
Circleville 319-326
Fort Seybert 326-8
Horton 328-37
McDowell 338-9
Onego 340-6
Petersburg 346-53
Spruce Knob 353-8
Levels, Railroad:
Baltimore & Ohio 346-7
Central W. Va. & Southern........
.... 329-30, 330-1
Lumber R. R. (Evenwood to Gladwin) 334-6
Western Maryland ..328-9, 333-4, 337
Lick Run 327, 351
Lick Run (of Kettle Creek) 48
Lick Run (of Little Fork).........49
Lickdale Series (Soils)...........306
Lillydale Shale.... 192, 195, 197, 203
Limbs of Anticlines and Synclines..227
Lime 286, 289, 293
Lime Burning, Keplinger Quarry......
........126-7, 129, **289**, 290, 291
Lime Burning, Limestone Suitable for
.... 79, 80
Lime Burning (Plate XXXVI) 129
Limestone 286-92
Limestone:
Alderson 188, **189**
Avis (Hinton) ..199, 286, 291, 292
Bossardville ....
84, 116, 120, 123, 124, 125, 126, **126-132**, 136, 247, 248, 249, 250, 255, 258, 259, 266, 272, 286, **289**, **290**, **291**, 302, 306
Chambersburg ....
77, 78, **78-79**, 81, 82, 86, 87, 89, 103, 262
Coeymans ....
133, 134, 136, 137, 138, 140, **290**, **291**

Page.

Limestone:
Fredonia ..186, 187, **189**, 291, 292
Glen Dean ....
187, 188, **189**, **191**, 192, **290**, 292
Glenray 193, 194, 196-7, 203-4
Greenbrier ....
24, 54, 178, 180, 181, 184, 186, 189, 191, 197, 286, 287, **291**, **292**, 302
Helderberg ....
130, 143, 149, 242, 243, 247, 250, 251, 252, 255, 257, 258, 259, 264, 266, 272, 286, 289, 296, 302
Hinton (Avis) ..199, 286, 291, 292
Keyser ....
132, 133, 134, 136, 140, 289, **290**, **291**, 306
McKenzie 290, 291
New Scotland ....
133, 134, 136, 137, 138, 139, 140, 141, 225, 255, 157, 258, **290**, **291**, 306
Niagara ....
84, 112, 113, 114, **114-19**, 120, 123, 247, 248, 249, 258, 262, 264, 266, 286, 287, **290**, **291**
Reynolds ....
193, 194, 196, **200**, 204, 205, 286, **291**, **292**
Rondout ....
84, 116, 120, 123, **124-6**, 247, 248, 258, 262, 266, 286, 289, **288**, **290**, **291**, 306
St. Louis 186
Selinsgrove ....
133, 147, 151, 152, 153, 223, **290**, **291**, **292**
Shenandoah 23, 37
Stones River ....
79-80, 81, 82, 86, 87, 89, 262, **291**, **292**, 302
Limestone Analyses ....
...........290-2, 297, 300, 315-16
Limestone, East of North Fork Mountain 287-9
Limestone for Building Purposes ..289-90
Limestone Quarry, D. R. Keplinger..
..**126-7**, 129, 130-1, **289**, 290, 291
Limestone Samples (Nos. 1 to 8)....189
Limestone Soils 305
Limestone Valley East of Seneca Rock and West of North Fork Mountain (Plate XV) 66
Limestone, West of North Fork Mountain 286-7
Limestone, Wills Mountain Anticline 287
Limonite 267, 270, 292
List of Collections and Analyses 314-16
Little Fork 43, 44, **49**, 58
Little Italy (Keeter School).......331
Little Mountain 197, 240, 279
Little Mountain, Iron Ore Analysis..279
Loam 307
Loam, Sandy 307
Location 1-2
Locations, Fossil (by Nos.):
4 125
5 and 6...................131-2
7 126
8 153
9 123-4
10 118-19
11 118
12 153
13 140-1
14 117
15 118

Page.

Locations, Fossil (by Nos.):
16 132
17 and 18.................. 164
19 ....154, 155-7
20 131
21, 22, and 23............. 140
25 113
26 113-14
27 165-6
30A, 30B, 31A, and 31B........112
33 166
34 .... 158, 166
35 166
36 .... 154, 158
37A 147, 151, 152
37B 152
37C 152, 153
38 .... 147, 151, 152-3
39 153
40 ....153, 158-9, 166
41 .... 113, 119
43 153
44 146
45 158
46 131
47 130-1
48 131
49 113
50 ....118, 125-6
51 117-18
52 146
53 113
54 168-9
55, 56, and 57 165
58 164-5
59 165
60 .... 154, 157-8
61 173-4
62 186
63 .... 192, 203
64 203-4
65 and 66 204
67 204-5
68 205
Locations, Fossil (by Series):
Bloomsburg 123-4
Bossardville 130-2
Chemung 173-4
Clinton 112-114
Genesee 164-6
Hamilton 155-9
Helderberg 136-141
Marcellus 151-4
Mauch Chunk 203-5
Niagara 117-119
Oriskany 146
Pocono 186
Portage 168-9
Rondout 125-6
Logs, Impressions and Casts........169
Lone Oak School 338, 339
Lone Poplar School 49, 155, 162, 323
Long Hollow School 343
Long Ridge ....
40, 61, 70, 105, 108, 116, 236, 243, 275, 278, 279, 287
Long Ridge Anticline **236**, 244, 258
Long Ridge-Elkhorn Mountain Anticlinal Area **235-6**, 242, 243, 244
Long Ridge, Iron Ore Analyses..278, 279
Long Ridge-South Fork-Thorn Ridge Anticlinal Area 231
Long Run ....
42, 44, 50, 187, 188, 192, 193, 194, **195**, 197, **198**, **199**, **200**, 202, 203, 204, 205, **216**, **217**, 247, 257, 283, 284, 292

Page.
Long Run Section (Mauch Chunk)... ....195-7, 281, 283
Longitude 1
Lookout, Fire, and Cabin on Shenandoah Mountain East of Sugar Grove (Plate LXXII) 260, 308
Lookout, Fire, (Spruce Knob)..308, 358
Lough & Co. Mill.................52
Lough, A. O. 351
Low-Angle Fault-Planes (Plates XVII and XXIX) 89, 101
Low-Angle Faults........80, 238, 250
Lower Clinton 111
Lower Connoquenessing Sandstone..206
Lower Devonian 133, 133-146
Lower Devonian Rocks, Map Showing (Figure 21) 135
Lower Devonian Section (Oak Flat) 133
Lower Devonian Shales 48
Lower Gilbert Sandstone 206
Lowest and Highest Elevations ..10, 38
Lumber Engine in Use Along the Headwaters of Seneca Creek (Plate LXXX) 309
Lumber Railroad (Evenwood to Gladwin), Levels 334-6
Lumbering 308
Lunice Creek 58
Lutheran Parsonage (Dorcas) 348

M

Maccrady Shale 181, 186
Macksville 19, 52, 142, 342
Magnetite 267, 270, 271, 272, 273
Magnetite, Titaniferous 273
Mails 18
Maintenance, Roads Under State 4-5
Mallow, J. M.............11, 12, 13
Mallow, Mrs. Maude 321
Mammals (Animals) and Birds on Spruce Mountain, List (by Brooks) 311
Manganese 280-1
Manganese, Analysis, Ore (Do) 281, 315
Manganese, Metallic 281
Manganese, Value 281
Map Showing:
Carboniferous Rocks (Figure 24) 179
Drainage System (Figure 4)......41
Iron-Bearing Series (Figure 25)..276
Lower Devonian Rocks (Figure 21) 135
Medina Sandstones (Figure 5)....68
Middle Devonian Rocks (Figure 22) 148
National Forests (Figure 3).....15
Ordovician Rocks (Figure 6)......75
Silurian Limestones (Figure 20) 115
Upper Devonian Rocks (Figure 23) 161
Map Symbols ....
61, 70, 72, 74, 78, 79, 105, 114, 124, 126, 134, 141, 149, 154, 160, 167, 171, 174, 178, 187, 192, 206, 213
Marcellus-Hamilton Contact 154
Marcellus-Oriskany Contact 146-7
Marcellus Series 133, 147, 149-154, 160
Marcellus Series:
East of North Fork Mountain...149-51
Locations (Fossil) 151-4
Map Symbol (Dm) 149
Paleontology 151-4
Thickness 147, 149, 150, 151
West of North Fork Mountain....149
Marcellus Shale ....
24, 35, 133, 137, 147, 149, 150, 151, 154, 155, 166, 167, 218, 219, 220, 222, 242, 251, 252, 253, 254, 255, 256, 257, 258, 259, 283, 303

Page.
Marl 288, 289
Martinsburg Shale ....
23, 37, 60, 73, 74-8, 78, 80. 81, 82, 83, 84, 85, 86, 87, 90, 95, 262, 264
Martinsburg Shale:
Areal Distribution 74
Character 75-6
Contacts 77-8
Divisions 76-7
Economic Character 78
Map (Figure 6) 75
Map Symbol (Oms) 74
Thickness 76
Maryland Geological Survey 111
Mason, T. W. 272
Masonry (Cheap) 296
Materials, Road 296-301
Materials, Road, Analyses 297-9, 301
Materials, Road, Tests 300
Matson, G. C. 272, 273
Mauch Chunk-Greenbrier Contact...192
Mauch Chunk-Pottsville Contact....205
Mauch Chunk Series...............
177, 178, 179, 187, 191, 192-205, 206, 216, 264, 265, 284, 306
Mauch Chunk Series:
Coals (Analyses) 284
Coals (Section) 283
Limestone 286, 287
Long Run (Section) 192-7
Map Symbol (Cmc) 192
Paleontology 202-5
Sandstones 294
Section (Long Run) 194, 195-7
Thickness 177
West of North Fork Mountain 192-202
Mauch Chunk Shales and Sandstones.. .... 24, 194
Mauch Chunk Shales and Sandstones (Green Knob) 201
Maysville Formation 76-7, 85
Meadows 328
Mean Sea-Level 318
Medina-Clinton Contact 105
Medina, Gray ....
23, 71, 72, 72-3, 77, 82, 84, 85, 86, 87, 88, 90, 262, 265
Medina, Gray:
Character 72-3
Contacts 73
Distribution 72
Economic Character 73
Map Symbol (Sgm) 72
Thickness 73
Medina, Red ....
23, 61, 62, 67, 69, 70, 70-2, 73, 82, 83, 84, 85, 86, 88, 97, 118, 248, 249, 250, 258, 262, 264, 294
Medina, Red:
Contacts 71-2
Economic Character 72
General Character 70-1
General Distribution 70
Map Symbol (Srm) 70
Thickness 71
Medina Sandstones ....
23, 24, 37, 39, 50, 60, 68, 74, 81, 82, 83, 143, 277, 287
Medina Sandstones, Map Showing (Figure 5) 68
Medina Sandstones, Section (Figure 14) 84
Medina, White ....
23, 30, 37, 39, 40, 50, 61-70, 70, 71, 74, 82, 83, 84, 85, 86, 87, 92, 93, 96, 97, 98, 104, 105, 107, 108, 109, 112, 113, 117, 118, 238, 241, 242,

Page.
Medina, White
243, 244, **245**, **246**, 247, 248, 249, 250, 258, 259, 262, 263, 264, 265, 293, 294, 296, 305
Medina, White, Formations Above the (Chapter IV) 104-226
Medina, White, Sandstone:
Areal Distribution 61-7
Contacts 69-70, 105
Economic Character 70
General Character 67-9
Map Symbol (Swm) 61
Thickness 69
Medium Sand 307
Melilite 267
Mercer-Monroe-Summers County Report 181, 186, 197, 202
Mesophytic Forest, Spruce Knob....312
Metallic Iron Content.......278-9, 280
Metallic Manganese 281
Metamorphism 270
Mica Flakes 267
Mica Peridotite Dike at Dixonville, Pa. 272, 273
Mick Run 126
Middle Clinton 111
Middle Devonian 133, **147-159**
Middle Devonian Rocks, Map Showing (Figure 22) 148
Middle Devonian Section 147
Middle Mountain 50, 52, 237, 336
Middle Mountain Synclinal Area 231, 243
Middle Mountain Syncline 162, 172
Middle Mountain ("Trough") Synclinal Area ..**236-7**, 241, 243, 244, 247
Middle Mountain ("Trough") Syncline 236-7
Mileage, Road 5
Mill Creek 42, 44, **45**, **58**, 107
Mill Creek Gap 104
Mill Creek (Judy Spring) 42, 43, 78, 81, 87, 262, 291, 301
Mill Run..42, 44, **46**, 52, 53, 168, 342
Mill Run District:
Area 10
Assessments 18
Population 16
Post-Offices 19
Miller, John 340
Miller Run 43, 44, **49**
Mills 303
Mineral Grains (Soil Types), Sizes, etc. 307
Mineral-Grant County Report 45, 55, 174, 202
Mineral-Hampshire-Hardy County Line (Schooley Peneplain) 27
Mineral Resources (Part III) ..274-316
Miscellaneous Items 8-20
Mississippian System 177-205
Mississippi Valley 186, 188
Mitchell 19
Mitchell, C. A. 351
Mitchell, Cyrus 353
Mitchell Mill 52
Moatstown 127
Model, Profile, Showing Physiographic Features of County (Plate III)...26
Monadnocks on the Harrisburg or Tertiary Peneplain 27
Monadnocks on the Schooley Peneplain 27, **27-9**, 210
Money-Order Post-Offices 19
Mongold, D. C 347
Monocline (Definition) 227
Monongahela National Forest........ ....14, 15, 56, 345
Monongahela Series 281
Monongalia County (Cmc) 202
Monterey 45, 48, 50
Monterey-Franklin Road 3, 298, 299
Monterey Sandstone 266
Montes 329, 334
Moore and Edwards 274
Moorefield 45, 48, 346
Moorefield (South Fork) River...... 30, 32, 37, 38, 39, 43, 44, 45, **48**, 49, 52, 55, **56-7**, **58**, 134, 143, 150, 153, 154, 160, 162, 166, 167, 170, 242, 244, 259, 277, 280, 286, 308, 323, 328
Morgan County (Hedges Shale).....184
Morton, Oren F. 8
Moser Knob 142, 291
Mount Hope Church 164, 233
Mount Horeb Church.............. ....46, 150, 162, 257, 258
Mount Horeb Church Section.......150
Mount Olive Church 220, 322
Mount Olive School (Terrace Deposits) 35, 220, 257, 258
Mount Pleasant School ..327, 351, 352
Mount Pleasant U. B. Church......342
Mountain Makers 23-24
Mountain Ranges 232
Mountains 10, 232
Mountains, Anticlinal 232, 241
Mountains, Synclinal 232, 242, 243
Mouth of Seneca.................. 19, 21, 39, 50, 52, 69, 72, 87, 124, 126, 134, 149, 154, 160, 167, 171, 172, 174, 175, 180, 201, 211, 218, 219, **239**, 262, 263, 264, 286, 341, 342, 343, 344
Mouth of Seneca (Flood-Plain, Terraces, etc.), (View), (Plate VIII) 36
Mouth of Seneca, Terraces....32, 35, 36
Moyer Gap, Iron Ore Prospect..275, 278
Moyer Gap (Judy Bridge).......... ..109, 112, 220, 275, 297, 324, 325
Moyer Run 43, 44, 70
Moyers, J. E.....................300
Moyers P. O. (Johnstown) ..19, 47, 325
Mozer 19
Muck 293
Mud 292, 293
Mules 17
Mullennux, J. S..................344
Municipal Water-Supplies 304-5
Mushroom Rock (Key)........87, 103

Mc

McCoy Mill 52
McCoys Mill 47, 322
McCrea, Walter 319, 327, 329, 340, 341, 346, 347, 352
McDonald Mill 52
McDonald Spring 42, 43, 78, 81, 87, 262, 292, 302
McDowell Quadrangle 317, 323, 326, 338
McDowell Quadrangle, Levels 338-9
McIntosh Run 50
McKenzie Formation 118, 119
McKenzie Limestone 290, 291
McReynolds, A. D................301

N

Narrow-Gauge Railroads 2
National Forests 13-15, 308
National Forests, Map Showing (Figure 3) 15
Neds Mountain 40

Page.
Needles of FeS_2....................203
Nelson Mill 52
New Bethel Church 150, 327
New Creek Mountain 39
New Erection School 123, 127
New Hopeville 343, 344, 345
New Road Run 49
New Scotland Cherty Limestone......
133, 134, 136, 137, 138, 139, 140, 141, 225, 255, 257, 258, **290**, **291**, 306
New York Academy of Science......272
New York State (Logs)..........169
Niagara-Clinton Contact.......... 114
Niagara (Limestone) Series.........
84, 112, 113, 114, **114-119**, 120, 123, 247, 248, 249, 258, 262, 264, 266, 286, 287, **290**, **291**
Niagara (Limestone) Series:
Contact (Clinton) 114
Contact (Salina) 119
East of North Fork Mountain....116
Locations (Fossil).......... 117-19
Map Showing (Figure 20)......115
Map Symbol (Sna) 114
Paleontology 116-19
West of North Fork Mountain...116
Niagara-Salina Contact 119
Nitrates 223
Nitze, H. B. E..................274
Noah Teter Hollow ....
.....69, 71, 73, 86, 87, 95, 98, 250
Noah Teter Hollow Section (Figure 15)
.... 84
North Branch of Potomac River......45
North Fork Church..............291
North Fork Mountain..............
3, 23, 24, **29-30**, 30, 37, **39**, 46, 47, 50, 62, 66, 67, 70, 71, 76, 81, 86, 87, 94, 100, 104, 105, 106, 107, 116, 119, 120, 124, 126, 134, 141, 142, 149, 154, 160, 162, 167, 169, 171, 172, 174, 176, 178, 181, 187, 191, 206, 218, 219, 220, 233, 237, 238, 240, 241, 243, 244, 250, 262, 263, 264, 277, 280, 287, 341
North Fork Mountain Anticlinal Area
.... 231
North Fork Mountain Anticline..37, 39
North Fork of Potomac River.......
30, 32, 37, 38, 39, 42, 43, 45, **49-50**, 50, 51, 52, 55, **56**, **58**, 107, 109, 142, 160, 175, 180, **207**, 219, 238, 240, 242, 243, 262, 264, 265, 275, 286, 302, 320, 341, 342
North Fork Road 3, 296
North From Franklin, Trip......251-4
North Mill Creek..................
42, 44, **45**, 46, **58**, 237, 244, 340, 347
North Potomac Syncline 240

O

Oak Flat ....
21, 125, 133, 134, 140, 142, 143, 146, 155, 159, 162, 223, 258, 291, 297, 301, 327, 328
Oak Flat Section (Lower Devonian)..133
Oak Flat, View East from (Plate IV) 28
Oak Grove 162, 291
Oak Grove School 132
Oats 17, 307
Observatories (Fire Lookout)........
.... 260, 308, 358
Oil and Gas 285
Oil, Gas, and Coal, With Reference to
.... 281-5

Page.
Olivine 267, 271, 272, 273
Onego ....
19, 21, 50, 52, 175, 177, 178, 180, 181, 185, 186, 187, 191, 192, 195, 197, 203, 208, 212, 219, 264, 292, 302, 344
Onego Quadrangle ....
317, 319, 320, 330, 340, 343, 346, 347, 350
Onego Quadrangle, Levels 340-6
Onego School 189
Onondaga Shale 147
Opal 273
Optical Analysis, Volcanic Breccia....271
Ordovician Rocks ....
23, **74-8**, 238, 241, 250, 295, 296, 302
Ordovician Rocks, Map Showing (Figure 6) 75
Ordovician Limestone....287, 290, 292
Ores, Iron 274-281
Origin of Rocks 23
Original Forest Conditions 308
Oriskany-Helderberg Contact 141
Oriskany-Marcellus Contact 146-7
Oriskany Sandstone................
24, 30, 35, 37, 39, 40, 46, 47, 48, 50, 53, 56, 57, 87, 126, 133, 134, 136, 137, 138, 141, **141-7**, 149, 151, 153, 155, 166, 220, 230, 242, 243, 244, 247, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 264, 266, 275, **276**, **279-80**, 287, 294, 296, 303, 305, 315
Oriskany Sandstone:
East of North Fork Mountain...142-3
Iron-Bearing Series (Map) (Figure 25) 276
Locations (Fossil) 146-7
Map Symbol (Do) 141
Paleontology 143-7
Smoke Hole (Plate LXVI) 230
Thickness 133, 141-2
West of North Fork Mountain..141-2
Oriskany Series, Iron Ores..279-80, 314
Oriskany Series, Iron Ores, Analyses 279-80
Oriskany Series, Manganese..280-1, 315
Orleans Anticline 235
Orton, Dr. Edward 274
Osceola 336, 354, 355, 357
Osceola School 357
Ottinger, Cyrus 327
Ours, S. Ray 350
Out From Franklin (Trips)....251-265
Out From Franklin (Trips):
Down Into Smoke Hole 254-7
East 258-9
North 251-4
South 257-8
West 259-265
Outcrops (See East and West of North Fork Mountain)
Outcrops, Chambersburg Limestone....78
Outcrops, Gray Medina 72
Outcrops, Iron Ore (Clinton)..275, 277
Outcrops, Martinsburg Shale 74
Outcrops, Red Medina 70
Outcrops, Stones River Limestone....80
Outcrops, White Medina (Tuscarora)..
.... 61-67
Overhang ....
106, 116, 144, 242, 243, 247, 250
Overlap 177
Overshot Wheels 52, 53, 54, 55, 303
Overthrust 249, 250, 257
Overturn 37, 249
Overturned Arch (Smoke Hole)....229

P

Page.

Paddy Run 47
Paleontology:
 Bloomsburg 123-4
 Bossardville 130-2
 Catskill 177
 Chemung 173-4
 Clinton 109-114
 Genesee 164-6
 Greenbrier 191-2
 Hamilton 155-9
 Helderberg 136-141
 Marcellus 151-4
 Mauch Chunk 202-5
 Niagara 116-119
 Oriskany 143-7
 Pleistocene and Recent 223-6
 Pocono 186
 Portage 168-9
 Rondout 125-6
Paleozoic Rocks 23
Palo Alto, Va....................
 155, 158, 162, 166, 168, 338, 339
Panoramic View from North Fork Mountain 87, 100
Panoramic View of Seneca Rock at Mouth of Seneca (Plate LXIX)..239
Pansy P. O. 347, 248
Panther Knob 29
Parkhead Formation 169
Parsons Quadrangle 329, 334
Part I—History, Physiography, and Water-Power 1-59
Part II—Geology 60-273
Part III—Mineral Resources....274-316
Passages, Underground.............
 46, 55, 56, 127, 136. 256, 258. 301, 302, 303
Pasturage 307
Patterson Creek Mountain (Schooley Peneplain) 27
Pawpaw Anticline 235
Pebbles 178, 182, 206, 213, 251
Pebbles, Calcareous 197
Pedestal Rock (Key) 87, 103
Pendleton County Levels.......319-358
"Pendleton, My Pendleton".........22
Peneplain, Harrisburg ....
 ....20, 23, 25, 27, 28, 30-32
Peneplain, Harrisburg, Monadnocks on 27
Peneplain, Harrisburg, Valleys Cut Below 27
Peneplain, Schooley 25-30
Peneplain, Schooley, Monadnocks on..
 27-29
Peneplain, Schooley, Remnants of 29-30
Peneplains 226, 256
Peneplanation 23
Pennsylvania State College, Mining and Metallurgical Experiment Station Bulletin 273
Pennsylvanian System 206-213
Peridotite 271
Peridotite Dike, Coal Measures, South-West Pennsylvania (Gates, Pa.)..272
Peridotite Dike, Mica, at Dixonville, Pa.
 .... 272, 273
Perkins, C. L. 14
Perofskite 272, 273
Perofskite Crystals 267
Personal Property, Valuation 18
Peru 327, 349, 350, 351, 352
Peters Mountain ....
 24, 40, 46, 62, 107, 234, 237, 243, 247, 248, 262, 264, 287
Peters Mountain Anticline 243
Peters Run 42, 44

Page.

Petersburg ....
 2, [illegible], 45, 50, [illegible]5, 150, 154, 157, 251, 253, 255, 346, 347, 348
Petersburg Branch, B. & O. R. R......2
Petersburg-Franklin Road ....
 ....3, 162, 164, 167, 172, 242, 296
Petersburg Gap 347
Petersburg Quadrangle ....
 .... 317, 327, 343, 346
Petersburg Quadrangle, Levels..346-35[illegible]
Phenocrysts 273
Pheris, Paul 341
Phlogopite 273
Phosphorus (in Iron Ores)..........
 ....278, 279, 280
Physiographic Features of County (Profile Model), (Plate III) ....2[illegible]
Physiographic Provinces 24
Physiography and Water-Power (Chapter II) 23-59
Physiography, History and Water-Power (Part I)...............1-59
Physiography of the Upper James River Basin 25
Pickle Mountain 142, 231, 236, 247, 25[illegible]
Picotite 272
Pine Knob 352
Pipestem Coal 202, 284
Pitch or Plunge (Anticlines and Synclines) 227
Pitzenberger, A. J., Iron Ore Prospect
 278
Plagioclase 271
Plagioclase Feldspars ....27[illegible]
Plants .... 30[illegible]
Plants and Trees, Spruce Knob.....311
Plants, Flowering, and Grasses, Spruce Knob 313
Plants, Fossil........(See Fossil Index)
Plants, Herbaceous, Spruce Knob..311-12
Plants on Spruce Knob (by Core) ..
 .... 311-31[illegible]
Plants on Spruce Mountain (by Brooks)
 .... 31[illegible]
Plants, Poisonous, Spruce Knob.....31[illegible]
Plants, Ruderal, Spruce Knob......312
Plaster Material ....29[illegible]
Plates (See Illustrations under Table of Contents)
Plates, Descriptions of (XVI to XXXI)
 86-87
Pleasant Grove Church........150, 327
Pleasant Valley Church............134
Pleistocene and Recent System..213-226
Pleistocene and Recent System:
 Contact With Folded Rocks..213-218
 East of North Fork Mountain..219-223
 Map Symbol (Qal) 213
 Paleontology 223-6
 Present River Boulders and Gravels
 218
 Present, The 226
 South Branch Valley 220
 South Fork Valley 220-3
 West of North Fork Mountain.218-219
Plunge or Pitch (Anticlines and Synclines) 227
Pocahontas County Levels 353-8
Pocahontas County (Logs) 169
Pocahontas County, Population per Square Mile 16
Pocono-Catskill Contact 177
Pocono Conglomerate (Plate XLV)..185
Pocono-Greenbrier Contact 186
Pocono Oil Sands 180

Page.

Pocono Sandstones ....
24, 37, 38, 39, 175, 176, 177, 178, 179, 187, 212, 243, 264, 265, 283, 294
Pocono Series.......178, 178-186, 188
Pocono Series:
Contacts 177, 186
East of North Fork Mountain...181-3
Map Symbol (Cpo) 178
Oil Sands 180
Paleontology 186
Questions of Correlation 183-4
Section (High Top) 182-3
Thickness 178, 182, 183
West of North Fork Mountain 178-181
Poisonous Plants, Spruce Knob.....313
Population by Districts 186
Portage-Chemung Contact..169-171, 173
Portage-Genesee Contact 166-7
Portage Series ....
133, 149, 152, 160, 162, 166, 167-171, 171
Portage Series:
Contacts 166-7, 169-171, 173
East of North Fork Mountain...167-8
Locations (Fossil) 168-9
Map Symbol (Dp) 167
Paleontology 168-9
Plate XLIV 170
Sandstones 294, 296
Thickness 159, 168
West of North Fork Mountain.....167
Portage Shale ....
24, 29, 37, 38, 194, 195, 205, 206, 259, 272
Portland Cement (Limestone for) ..78
Post-Offices 19
Postal Service 18-19
Potomac River 25, 45
Pottsville Conglomerate ....
24, 29, 37, 38, 194, 195, 205, 205, 209, 210, 211, 214, 215, 238, 242, 264, 265, 281
Pottsville-Mauch Chunk Contact....205
Pottsville Sandstones 293, 294, 295, 305
Pottsville Series ....
178, 179, 191, 206, 206-213, 281, 284, 294, 296
Pottsville Series:
Coal 283
Contact, Mauch Chunk 205
Map Symbol (Cpv) 206
Thickness 206, 213
West of North Fork Mountain 206-213
Pound Mill Run 180
Power Plant at Franklin 52
Power, Water-................ 52-59
Power, Water-, History and Physiography (Part I) 1-59
Power, Water-, and Physiography (Chapter II) 23-59
Precipitation 301
Precipitation, Brandywine 11
Precipitation, Upper Tract 11
Present, The 226
Present Development, Water-Power 52-55
Present Forest Conditions.......308-10
Present River Boulders and Gravel..218
Present Stream Levels 25
Present Topographic Features.....37-40
Preston County Report 202
Pretty Ridge 40, 237
Pretty Ridge School 255
Price, Paul H. ....
1, 9, 14, 17, 20, 26, 28, 31, 33, 34, 40, 43, 53, 67, 74, 110, 116, 121, 122, 128, 129, 134, 137, 138, 139,

Page.

Price, Paul H.:
144, 145, 147, 156, 160, 162, 163, 170, 178, 185, 190, 198, 209, 210, 214, 215, 221, 222, 224, 229, 230, 233, 234, 245, 246, 260, 261, 263, 268, 269, 275, 295
Priest, Paul R. 305
Princeton Sandstone ....
..........194, 195, 197, 202, 283
Products 17
Profile Model Showing Physiographic Features of County (Plate III).....26
Projects, Data on Federal Aid (Road) 6
Projects, Data on State Aid (Road)...5
Projects, Data on State (Road)....6-8
Projects, (Road) 4-8
Property, Personal, Valuation.......18
Property Valuation 17-18
Proposed Railroads 2-3
Proposed Sites for Dams....55, 56, 57
Props Knob 291
Props Run 42, 44, 61, 291
Props Run Road Section (Figure 12) 83
Propst, T. H. 326
Prospects, Iron Ore 275
Prouty, Wm. F. ....
60, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 101, 102, 103, 250
Public Utilities, Valuation 18
Purposes, Water for Domestic....301-5
Purslane Conglomerate (Sandstone)..
......181, 182, 183, 184, 259, 294
Pyroxene 267, 271, 273

Q

Quantity of Clinton Iron Ore, Estimate
.... 277-8
Quantity of Water Used at Franklin 303
Quarry, Limestone, D. R. Keplinger..
126-7, 129, 130-1, 287-9, 290, 291
Quartz 293, 294
Quartzite 69, 294
Questions of Correlation (Pocono) 183-4

R

Railroads, Narrow-Gauge 2
Railroads (None in County).........2
Railroads, Proposed 2-3
Rains 10
Rain-Water 302
Randolph County, Levels............
..............328-37, 340-6, 353-8
Randolph County (Logs) 169
Randolph-Pendleton County Line (Limestone) 286
Ranges, Mountain 232
Rate of Fall of Streams 42-43
Ratio, Fixed Carbon (Coals)......284-5
Ratio, Total to Air-Line Distance (Streams) 42-43
Real Estate Valuation 18
Recent and Pleistocene System 213-226
Recent and Pleistocene System:
Contact With Folded Rocks..213-218
East of North Fork Mountain.219-223
Map Symbol (Qal) 213
Paleontology 223-6
Present River Boulders and Gravels 218
Present, The 226
South Branch Valley 220
South Fork Valley 220-3
West of North Fork Mountain 218-219
Red Creek 345
Red Creek Junction 329, 330, 344, 345
Red Creek Road 343, 345
Red Lick Run 42, 44

Page.
Red Medina ....
23, 61, 62, 67, 69, 70, **70-2**, 73, 82, 83, 84, 85, 86, 88, 97, 118, 248, 249, 250, 258, 262, 264, 294
Red Medina:
Contacts 71-72
Economic Character 72
General Character 70-71
General Distribution 70
Map Symbol (Srm) 70
Thickness 71
Red Shale 186
Red Shales and Sandstones (Soil)...306
Reeds Creek ....
42, 44, **46**, 149, 252, 253, 291, 319, 341
Reference to Coal, Oil, and Gas, With
.... 281-5
Refractory Material 70
Reger, D. B. ....
......169, 181, 186, 202, 240, 285
Regolith 305
Relief 10, 37
Remnants of the Schooley Peneplain..
.... 27, 29-30
Report, State Road Commission (1926)
........................4, 5, 6,
Reservoir, Proposed 59
Reservoir (Water) 304
Resistant Rocks of County, Geologic Column (Building) (Plate LXXIX)
.... 295
Resources, Mineral (Part III) ..274-316
Restored Surface, The 24-25
"Reunion Grounds" (Thorn Creek) (Plate VI) 33
Rexrode 19
Reynolds Limestone ....
193, 194, 196, **200**, 204, 205, 286, **291**, **292**
Reynolds Shale 196
Ridge Makers 23, 24
Ridgeley Sandstone 133, 141, 142, 146
Ridgeley Sandstone ....
.... (See Oriskany Sandstone)
Ridges, Scenery Across (Plates LXVII and LXVIII) 233, 234
Rise (Anticlines and Synclines).....227
River and Terrace Deposits, Contact Between Folded Rocks and 213-218
River Boulders and Gravels, Present..218
River Deposits 264
River Gravels 213, 218
River Knobs ....
23, 24, 36, **38-39**, 50, 81, 87, 104, 231, 238, 241, 242, 244, 250, 262, 264, 265
River Ridge 107, 109, 159
River Terraces 32-36, 218
River Terraces (Plates) ..221, 222, 224
River Valley Clays 213
River Valley Sands 213
River Water 301, 304
Rivers (Transportation) 2, 3
Riverton ....
19, 21, 52, 69, 71, 73, 219, 250, 264, 319, 320, 341, 342
Riverton Gap 86, 87, 93, 96
Riverton Gap Section (Figure 17)..85
Road Cut Through White Medina Sandstone on New State Route from Franklin to Mouth of Seneca, on East Side of North Fork Mountain (Plate LXXIV) 263
Road Data 4-8
Road Materials 286-301
Road Materials, Analyses....297-9, 301
Page.
Road Materials, Tests 300
Road Mileage 5
Road Run 43, 44
Roads 2-8
Roaring 19
Roaring Creek ....
42, 43, 50, 52, 180, 187, 188, 189, **190**, 191, 192, 193, 194, 203, 212, 219, 264, 286, 292, 302, 303, 344
Roaring Plains ....
24, 29, 38, 50, 51, 180, 191, 197, 205, 206, **209**, 211, **214**, **216**, **217**, 231, 240, 241, 254, 264, 281, 284, 285, 310
Roaring School 187, 188, 190, 286, 292
Robaugh, Perry 343
Rock, Analysis 297
Rock, Igneous (Chapter VI)....266-273
Rocks Below the Clinton (Chapter III)
.... 60-103
Rocks, Folded, Contact Between, and Terrace and River Deposits..213-218
Rocks, Weathering of 305
Rockwell Formation 181, 182, 183, 184
Rockwood Formation 24, 105
Romney Shale 166
Rondout Limestone and Shale........
84, 116, 120, 123, **124-6**, 247, 248, 258, 262, 266, 286, 289, **290**, **291**, 306
Rondout Limestone and Shale:
East of North Fork Mountain..124-5
Locations (Fossil) 125-6
Map Showing (Figure 20).......115
Paleontology 125-6
Thickness 120, 124, 289
West of North Fork Mountain...124
Root Run 42, 43
Rosiclaire Formation 188
Ross, J. G. 272
Rough Run ....
43, 44, 45, **48-9**, 168, 172, 349, 350
Rough Run School 349, 350
Route 28 5
Route 53 5
Routes, State 3-4, 5
Roy, M. J. 329, 330
Royal Glen Mill 55
Ruddle ....
19, 21, 46, 52, 107, 116, 120, 124, 125, 127, 129, 130, 149, 222, 237, 252, 256, 287, 291, 319, 320, 321, 346
Ruddle, Philip 321
Ruddle P. O................320, 321
Ruderal Plants, Spruce Knob.......312
Ruleman Mountain ....
40, 47, 62, 108, 231, 237, 246, 247, 248, 287
Rutile 267, 270, 271, 273
Rye 17

S

St. Louis Limestone 186
Salina-Helderberg Contact....... ..122
Salina Series 120-132
Salina Series ....
(See Bloomsburg, Bossardville, and Rondout)
Saltpeter 255
Samples, Coal, Analyses 284
Samples, Limestone (Nos. 1 to 8)..189
Sand.... 218, 219, 220, 223, 294, 298
Sand, Beckett 180
Sand, Berea 180, 181
Sand, Big Injun 180, 181
Sand, Coarse 307

Page.
Sand, Fine 307
Sand, Medium 307
Sand Mountain 149
Sand, Sandstone, and Gravel......293-6
Sand, Squaw 180
Sand, Very Fine 307
Sand, Weir 180
Sands, Oil and Gas............180-181
Sands, River Valley and Terrace 213
Sandstone:
Bertha 193, 194, 196, 197
Bloomsburg ....
108, 113, 117, 119, 120, **120-4**, 124, 126, 247, 248
Cacapon 105
Clinton 275, 278, 294, 315
Connoquenessing, Lower 206
Connoquenessing, Upper 206
Cypress 190
Droop 193, 194, 196, 197
Gilbert, Lower 206
Graham 195
Gray Medina ....
23, 71, 72, **72-3**, 77, 82, 84, 85, 86, 87, 88, 90, 262, 265
Hendricks ....
159, 171, 172, 173, 174, 176, 259
Hinton 194, 195
Iron 69, 109
Keefer ....
105, 106, 107, 108, 109, 110, 112, 113, 114, 117, 118, 120, 249
Lackawaxen Conglomerate 173
Lower Connoquenessing 206
Lower Gilbert 206
Monterey 266
Oriskany ....
24, 30, 35, 37, 39, 40, 46, 47, 48, 50, 53, 56, 57, 87, 126, 133, 134, 136, 137, 138, 141, **141-7**, 149, 151, 153, 155, 166, 220, 230, 242, 243, 244, 247, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 264, 266, 275, **276**, **279-80**, 287, 294, 296, 303, 305, 315
Pottsville Conglomerate ....
24, 29, 37, 38, 194, 195, 205, 206, **209**, 210, 211, **214**, **215**, 238, 242, 264, 265, 281
Princeton ..194, 195, 197, 202, 283
Purslane 181, 182, 183, 184, 259, 294
Red Medina ....
23, 61, 62, 67, 69, 70, **70-2**, 73, 82, 83, 84, 85, 86, 88, 97, 118, 248, 249, 250, 258, 262, 264, 294
Ridgeley 133, 141, 142, 146
Ridgeley ....(See Oriskany)
Sharon Conglomerate 206, 210
Tuscarora **61-70**, 105
Tuscarora ......(See White Medina)
Upper Connoquenessing 206
Webster Springs ..193, 194, 196, **198**
White Medina ....
23, 30, 37, 39, 40, **61-70**, 70, 71, 74, 82, 83, 84, 85, 86, 87, 92, 93, 96, 97, 98, 104, 105, 107, 108, 109, 112, 113, 117, 118, 238, 241, 242, 243, 244, **245**, **246**, 247, 248, 249, 250, 258, 259, 262, 263, 264, 265, 293, 294, 296, 305
Sandstone, Analyses 278, 297, 299, 314
Sandstone, Calcareous, Analyses 297, 300
Sandstone, Sand, and Gravel......293-6
Sandstone Soils 304-5
Sandstones, Color of 293, 294
Sandy Clay 307

Page.
Sandy Loam 307
Sandy Ridge ..40, 153, 258, 294, 296
Sandy Soil 307
Sawmill Branch 52
Sawmill Run 42, 43, 134, 342
Sawmills 308
Scenery (Extremes) 254
Scherr 343
Schmucker School 150, 223, 351
Schooley Peneplain ....
........25, **25-30**, 30, 37, 45, 209
Schooley Peneplain, Monadnocks on...
.... 27-9, 210
Schooley Peneplain, Remnants of......
.... 27, 29-30
Second Terrace................32, 35
Sections, Cross- 240-4, 244, 247
Sections, Cross- and Profile:
Castle Mountain (Figure 13).....84
Circleville Gap (Figure 18)......85
Circleville Gap (Lower-Middle Red Medina) (Figure 19)..........85
Eden Division of Martinsburg (Figure 16) 85
Franklin-Circleville Road (Old) (Figure 11) 83
Germany Settlement, North (Figure 8) 82
Hardscrabble Church (Figure 10)..83
Key (Figure 7) 82
Medina Sandstones (Figure 14)....84
Noah Teter Hollow (Figure 15)...84
Props Run Road (2 Miles S. E. of Franklin) (Figure 12).........83
Riverton Gap (Figure 17)........85
Simmons-Brushy Mountain (Figure 9) 82
Sections, General:
Clinton Series 105-6
Greenbrier 189
Lower Devonian 133
Mauch Chunk (Long Run) 195-7, 283
Middle Devonian 147
Upper Devonian 159-160
Sections, Geologic:
High Top 182-3
Long Run (Mauch Chunk)........
....................195-7, 283
Mt. Horeb Church..............150
Sedimentary Origin of Rocks........23
Seepages, Underground 252
Seitz, R. C. 357
Selinsgrove Limestone ....
133, 147, 151, 152, 153, 223, **290**, **291**, **292**
Selinsgrove Shale ....
......133, 146, 147, 150, 151, 152,
Semi-Centennial History of W. Va....57
Seneca Creek ....
42, 43, **50**, **58**, 141, 177, 180, 185, 189, 191, 218, 219, 238, 264, 286, 308, 309
Seneca Falls, N. Y...............304
Seneca Rock(s) ....
39, 74, 87, 99, 104, 106, 114, 116, 120, 124, 126, 134, 141, 142, 211, 264, 278
Seneca Rock (Cathedral Arch) (Plate XIV) 65
Seneca Rock, Clinton Sandstone Analysis 278
Seneca Rock, Limestone Valley East of, and West of North Fork Mountain (Plate XV) 66
Seneca Rock (Panoramic View) (Plate LXIX) 239

Page.
Seneca Rock, Views ....Frontispiece, 51, 63, 64
Seneca Rock Gap..........87, 99, 278
Seneca-Smoke Hole Extension Area (National Forests) 14, 15
Seneca Trail 211
Seng Run 49
Serecite 271
Serpentine 270, 272, 273
Service, Postal 18-19
Shafter Run 42, 43, 106, 116, 286
Shale:
Ada 196, 205
Bickett 196
Cypress 187, 188, **189**, **192**
Genesee 24, 160, 163, 167, 220, 242, 254, 259
Glenray 193, 194, 196
Hackett 195, 283
Hamilton 24, 35, 149, 150, 152, 153, 154, 156, 160, 162, 166, 220, 242, 254, 259, 302
Hedges 183, 184
Lillydale 192, 195, 197, 203
Marcellus 24, 35, 133, 137, 147, 149, 150, 151, 154, 155, 166, 167, 218, 219, 220, 222, 242, 251, 252, 253, 254, 255, 256, 257, 258, 259, 283, 303
Martinsburg 23, 37, 60, 73, **74-8**, 78, 80, 81, 82, 83, 84, 85, 86, 87, 90, 95, 262, 264
Onondaga 147
Portage 24, 164, 166, 167, 220, 242, 254, 259, 272
Reynolds 193, 194, 196, **200**, 204, 205, 286, **291**, **292**
Romney 166
Rondout 84, 116, 120, 123, **124-6**, 247, 248, 258, 262, 266, 286, 289, **290**, **291**, 306
Selinsgrove 133, 146, 147, 150, 151, 152
Shale, Analyses 298, 299, 301
Shale and Clay 292-3
Shale, Martinsburg 23, 37, 60, 73, **74-8**
Shale, Martinsburg:
Areal Distribution 74
Character 74-6
Contacts 77-8
Divisions 76-7
Economic Character 78
Map (Figure 6) 75
Map Symbol (Oms) 74
Thickness 76
Shale Road 253
Shale Valley 242, 259
Shales, Color of 292
Shalibo, F. L. 326, 340, 346, 348
Sharon Conglomerate and Shale 206, 210
Sharp Ridge 105
Shaver Run 46, 236
Shavers Fork 334
Shaw Ridge 49
Sheep 17
Shenandoah Limestone..........23, 37
Shenandoah Mountain 1, 10, 24, 28, **30**, 32, 37, **39**, 48, 49, 159, 162, 168, 172, 173, 176, 177, 181, 183, 184, 235, 243, 254, 259, 265, 297, 308

Page.
Shenandoah Mountain Fire Lookout and Cabin (Plate LXXII) 260
Shenandoah Mountain Synclinal Area 228, 231, 235
Shenandoah Mountain Syncline 38, **235**, 244
Shenandoah Mountain, View S. W. from Tower (Plate LXXIII) 261
Shenandoah National Forest 14, 15, 259
Shenandoah River 259
Shenandoah Tower 49, 183, 210, 260, 261
Shobe, Isaac 348
Shrader, Cletus 298
Shriver Chert 133, 142, 146
Shrubs 308
Siderite 273
Sideways (Anticlines and Synclines) 228
Silica 293, 296, 306
Silica (in Iron Ores) 278, 279, 280
Silica (in Limestone) 287, 289
Silt 307
Silurian Limestones 24, 241, 286
Silurian Limestones, Map Showing (Figure 20) 115
Silurian Report (Maryland Geological Survey) 111
Silurian Rocks 241
Simmons-Brushy Mountain Section (Figure 9) 82
Simmons, Isaac 349
Simmons, Mervin, Limestone Analysis 290, 291
Simmons Mill 52
Simmons Mountain 40, 62, 70, 81, 105, 108, 143, 231, 237, 244, 258, 277, 287
Simmons Mountain Anticline 70, 74
Simmons Mountain Iron Ore.......277
Simmons, W. P. 339
Simoda 19
Sink-Holes 262, 302
Sinks 81, 87, 102
Sinnet School 325, 326, 339
Sites for Dams 55, 56, 57
Size of Farms, Average 17
Slickensides 153
Slope (Dip) 227
Smith, C. B. (Brick Plant)......292-3
Smith Creek 42, 44, **47**, 70, 136, 143, 249, 302, 321
Smith Mountain 51, 175, 180, 189, 191, 197, 241, 264, 286
Smoke Hole 121, 139, 141, 143, 144, 149, 241, 244, 254, 255, 257
Smoke Hole Cave 302
Smoke Hole, Down Into (Trip)..254-7
Smoke Hole-Seneca Extension Area (National Forests) 14
Smoke Hole Settlement 56, 145, 237, 241, 244
Smoke Hole Settlement, Entering (Plate LXV) 229
Smoke Hole Settlement, Oriskany Arch (Plate LXVI) 230
Snowfall, Brandywine 12
Snowfall, Upper Tract 12
Snowy Mountain 70, 72, 74, 81, 241, 243
Soft Water 303
Soil, Alluvial 305, 307
Soil, Colluvial 305
Soil Survey 307
Soil Types (or Classes) 305-7

Page.
Soils 213, 226, 292, **305-7**
Soils, Limestone 306
Soils, Sandstone 305-6
Soils, The 305-7
Solution 302. 303
Souder, B. 353
South Branch (of Potomac) River...
3, 10, 30, 32, 37, 38, 39, 40, 42, 43, 44, **44-5**, 46, 47, 48, 50, 52, 55, **55-6**, 62, 70, 108, 109, 127, 134, 138, 143, 149, 154, 157, 160, 162, 164, 167, 172, 207, 237, 241, 243, 244, 253, 255, 257, 277, 280, 289, 308, 324, 340
South Branch (of Potomac) River, Indicated Horse-Power Developed by..59
South Branch (of Potomac) River, Indicated Horse-Power Developed by Tributaries of 58
South Branch P. O. 45
South Branch Valley (Qal)........220
South Branch Valley, Terraces (Plate LXII) 222
South Fork-Long Ridge-Thorn Mountain Anticlinal Area 231
South Fork (Moorefield) River......
30, 32, 37, 38, 39, 43, 44, 45, **48**, 49, 52, 53, 55, **56-7**, **58**, 134, 143, 150, 153, 154, 160, 162, 166, 167, 170, 242, 244, 259, 277, 280, 287, 308, 323, 328
South Fork Mountain ....
39-40, 46, 48, 116, 124, 127, 143, 242, **277**
South Fork Mountain, Iron Ore 277
South Fork River, Terrace Deposits (Plate LXI) 221
South Fork River, Terrace Deposits (Plate LXVII) 224
South Fork Road ..296, 326, 327, 352
South Fork Valley (Qal)........220-3
South From Franklin (Trip)......257-8
South Mill Creek 42, 44. **45**, **58**, 235, 237
Specific Gravity (Limestone and Sandstone) 300
Spring Brook 346
Spring Mountain (Iron Ore)........280
Springs 188, 262, 301, 303
Spruce Knob ....
10, 37, 38, 50, 180, 205, **210**, 213, 215, 238, 242, 254, 264, 265, 308, **311-313**, 358
Spruce Knob, Plants, Trees, etc. (Core) 311-313
Spruce Knob Quadrangle ....
..........317, 320, 330, 336, 353
Spruce Knob Quadrangle, Levels...353-8
Spruce Knob Trail 265
Spruce Mountain ....
29, 37, **38**, 50, 52, 61, 180, 191, 195, 197, 203, 206, 231, 240, 241, 242, 262, 264, 281, 284, 286, 306, 308, 310, 311, 358
Spruce Mountain, Animals (Mammals) and Birds on, List (Brooks)......311
Spruce Mountain, Plants on, List (Brooks) 310
Spruce Mountain Syncline 240
Spruce Mountain Triangulation Station and Fire Lookout 358
Spruce Run 47
Squaw Sand 180
Stalactites 255
Stalagmites 255
Stark School 357
State Aid Projects, Data on (Roads)..5
State Bonds (Apportioned to County)..4

Page.
State Forester 308
State Maintenance, Projects Under (Roads) 4-5
State Projects, Data on (Roads)...6-8
State Road Commission ....
..............3, 4, 5, 6, 297, 300
State (Road) Funds Apportioned..4, 5
State Road Work Done by County....4
State Road Work Done by State......4
State Routes 3-4, 5
Staunton Folio (No. 14)..........266
Staunton, Va. 2
Stock (Live) 17
Stone, Building 73
Stone Mountain 39, 127, 143, 236, 244
Stone Mountain Anticline 236, 244, 266
Stones River Limestone ....
78-80, 81, 82, 86, 87, 89, 262, **291**, **292**, 302
Stones River Limestone:
Economic Character 80
Map Symbol (Osr) 79
Outcrop 80
Stony Creek 42, 44
Stony Highlands 307
Stony River Synclinal Area 231
Stony River Syncline ....
........87, **238-40**, 241, 242, 243,
Stony River-Wellersburg Synclinal Area
................238-40, 264, 265
Stony Run ....
...43, 44, 151, 153, 158, 165, 223
Stony Run (Sugar Grove District) 43, 44
Stose, G. W. 27
Straight Fork 42, 44, 50, **52**
Straight Run 43, 44, 57, 235
Strata 227
Strauter Run 47
Stream Data, Table of 40-43
Streams, Available (Water-Power) 55-59
Streams, Indicated Horse-Power of 57-59
Streams, Length, Fall, etc. 42-3, 58, 59
Strike (Definition) 227
Strike, General, of Region 24
Structure in General 231-4
Structure, The Geologic (Chapter V)
.... 227-265
Subdivisions of Devonian System..132-3
Subsidence 186
Subsoil 305, 307
Sugar Grove ....
19, 21, 52, 108, 113, 123, 124, 143, 151, 155, 158, 165, 168, 173, 176, 183, 220, 221, 259, 260, 292, 297, 323, 324, 325, 338
Sugar Grove District:
Area 10
Assessments 18
Population 16
Post-Offices 19
Sugar Grove, Terraces 35
Sugar Run 49
Sulphur (in Iron Ores)..278, 279, 280
Sulphurous Water 303
Summers County (Schooley Peneplain)
.... 27
Surface, The Restored 24-25
Surface Water 302
Survey, Soil 307
Sweedlin Hill ....
.... 48, 143, 150, 240, 279, 280
Sweedlin Hill Anticline 235, 242
Sweedlin Valley 154, 162, 235
Sweedlin Valley School 155
Swine 17

Page.
Symbols, Map ....
61, 70, 72, 74, 78, 79, 105, 114, 124, 126, 134, 141, 149, 154, 160, 167, 171, 174, 178, 187, 192, 206, 213
Symmetrical (Anticlines and Synclines) 227-8
Synclinal Area, Middle Mountain ("Trough") 236-7
Synclinal Area, Stony River-Wellersburg 238-40
Synclinal Areas 231
Synclinal Mountains 232, 242, 243
Syncline, (Definition) 227, 232
Syncline, Blue Rock 237
Syncline, Deep Spring 235-6
Syncline, Georges Creek 240
Syncline, Middle Mountain ("Trough") 236-7
Syncline, North Potomac 240
Syncline, Shenandoah Mountain 235
Syncline, Spruce Mountain 240
Syncline, Stony River 238-240
Syncline, Wellersburg 240
System, Drainage, Map Showing (Figure 4) 41

T

Table of Stream Data 40-43
Tables Showing:
Elevation of Terraces 35
Indicated Horse-Power Developed by South Branch of Potomac River..59
Indicated Horse-Power Developed by Tributaries of South Branch of Potomac River 58
Road Material Tests by State Road Commission 300
Stream Data 42-43
Tanyard Gap 180
Tea Knob 108
Temperature, Average Annual 10
Temperature, Brandywine 13
Temperature, Lowest Recorded 10
Temperature, Upper Tract 13
Tennesseean Division of Mississippian 186, 188
Terms Used (Structure) 227-8
Terrace Clays 213
Terrace Deposits ....
213, 218, 219, 220, 223, 292, 293, 305, 306, 307
Terrace Deposits and Folded Rocks, Contact Between 213-18
Terrace Deposits of South Fork River (Plate LXI) 221
Terrace Structure (Definition)......227
Terraces, Mouth of Seneca..32, 35, 36
Terraces, River ....
32-36, 218, 251, 252, 253, 258, 264, 293
Terraces, River, Intervals 32, 35
Terraces, River (Views of)..........
.... 33, 34, 36, 221, 222, 224
Tertiary Peneplain 23, 25, **30-32**
Tertiary Peneplain, Monadnocks on....27
Testing Department, State Road Commission 297, 300
Tests, Road Material 300
Tests, Water 305
Teter Camp Run 52
Teter Gap 104
Teter, George 319
Teter Hollow, Noah................
...69, 71, 73, 86, 87, 95, 98, 250
Teter Hollow, Noah, Section (Figure 15) 81
Teter Run 42, 44
Teterton 19
Thickness:
Bloomsburg 120, 123
Bossardville 120, 126-7, 289
Catskill 159, 172, 176, 177
Chambersburg Limestone 78-9
Chemung 159, 171, 172, 173
Clinton Iron Ores 275, 277
Clinton Series 106
Coals 195, 281, 283, 284
Cypress Shale 189
Gasper, Upper Union (Fredonia)..189
Genesee 160, 162
Glen Dean, Alderson Limestone..189
Gray Medina 73
Greenbrier Limestone ....
..........24, 177, 187, 188, 189
Hamilton 147, 154, 155
Helderberg 133, 134
Iron Ores 275, 277
Lower Devonian 133
Marcellus 147, 149, 150, 151
Martinsburg Shale 23, 76
Mauch Chunk Shales and Sandstones 24, 193, 194, 195, 196, 197, 202
Medina Sandstones 23
Middle Devonian 149
Niagara 114, 116
Oriskany Series 133, 141-2
Pocono 178, 182, 183
Portage 159, 168
Pottsville 206, 213
Red Medina 71
Rondout Shale and Limestone.....
.... 120, 124, 289
Upper Devonian 159-160
White Medina (Tuscarora) 69
Third Terrace 32, 35
Thorn Creek 42, 44, **47-8**, 52, **58**, 137
Thorn Creek Flood-Plain ("Reunion Grounds") (Plate VI) 33
Thorn Mountain 40, 47, 143, 236
Thorn Mountain-South Fork-Long Ridge Anticlinal Area 231
Thornwood 356, 357
Thorny Run 49
Throw (Displacement) ..247, 249, 250
Thrust-Faulting 231, 243, 249, 250, 262
Tibbets, W. T. 298, 299
Tile Material 293
Tilton, John L. ....
36, 54, 104, 199, 200, 201, 211, 212, 216, 217, 225, 227, 251, 266, 274, 282, 288, 309
Timber 2, 307
Timber Ridge ....
40, 50, 149, 191, 197, **208**, 231, 264, 286
Titaniferous Magnetite 273
Tonnage Iron Ores 277
Topographic Features 232
Topographic Features, Present....37-40
Topography 10, 81
Totten Chapel 291
Toughness Tests 300
Town Mountain, Iron Ore 279, 280
Towns and Industries 21-22
Transportation 2-9
Trees 308
Trees, Spruce Knob 310
Trees, Variety of 308
Trenton (Limestone) 76, 77, 85, 86, 90
Tributaries of South Branch of Potomac River, Indicated Horse-Power Developed by 58
Trips Out from Franklin......251-265

Page.
Trips Out From Franklin:
Down Into Smoke Hole 254-7
East 258-9
North 251-4
South 257-8
West 259-65
Troublesome Valley 258
Trough (Middle Mountain) Synclinal Area 231, **236-7**, 243
Trough (Middle Mountain) Syncline.. .... **236-7**, 241, 243, 244, 247
Trough, The 237
Trout Cave ..136, 141, 223, 257, 302
Trout Cave, Entrance (Plate LXIV) 225
Trout Pools 257
Trout Run Dam 56
Trout Run (Troublesome Valley) 3, 42, 44, **47**, 70, 258
Trumbo, J. W. 326
Tucker County Levels 328-37, 340-6
Tucker, R. C. 317
Tuff 271
Tunnel Station 328
Turkey Knob Road 348
Turner, Casper 352
Turner, Joseph 346
Tuscarora (White Medina) Sandstone.. .... **61-70**, 105
Tuscarora (White Medina) Sandstone.. ......(See White Medina Sandstone)
Tuscarora (White Medina) Sandstone, Map Symbol (Swm) 61
Twin Run 47, 107, 118, 249
Tyler Series (Soils) 307
Type of Construction (Road)......300
Types, Soil 305-7

U

Ulrich and Bassler 111
Unconformities 69, 218
Underground Passages 46, 55, 56, 127, 136, 256, 258, 301, 302, 303
Underground Seepages 252
Underground Waters 81
Union District:
Area 10
Assessments 18
Population 16
Post-Offices 19
Union, Upper, Division (Cgr)....... ......187, 188, 189, 192, 291, 292
U. S. Bureau of Soils............307
U. S. Census 16, 17
U. S. Department of Agriculture....307
U. S. Geographic Board 48
U. S. Geological Survey............ ......9, 43, 48, 57, 105, 235, 316
U. S. Geological Survey Levels ..317-358
U. S. Weather Bureau 11
University of Chicago 271
Unsymmetrical (Anticlines and Synclines 228
Unsymmetrical Arch (Smoke Hole)..229
Uplifts 23, 25, 27
Upper Clinton **111**, 113
Upper Connoquenessing Sandstone...206
Upper Devonian 133, **159-177**
Upper Devonian Rocks, Map Showing (Figure 23) 161
Upper Devonian Section 159-160
Upper Reeds Creek School......125, 248
Upper Tract 10, 11, 13, 19, 21, 40, 46, 52, 55, 56, 140, 142, 149, 150, 154, 157, 162, 164, 168, 220, 253, 254, 291, 300, 319, 340, 341, 345, 350, 351

Page.
Upper Tract:
Average Temperature, Monthly 13
Precipitation 11
Snowfall, Monthly 12
Terraces 35
Upper Tract Bridge 297
Upper Tract-Grant Line Road.....297
Upper Tract P. O. 340, 346
Upper Union Division (Cgr) 187, 188, 189, 192, 291, 292
Upshur Series (Soils)............306
Upwarped (Anticlines and Synclines) 227
Utilities, Public, Valuation..........18

V

Valley Makers 24
Valley of Virginia 259
Valley Peneplain 25
Valleys 10
Valleys Cut Below the Harrisburg Peneplain 27
Valuation, Property 17-18
Value, Iron Ores 277
Value, Manganese 281
Vance Run 175
Variety of Trees 308
Very Fine Sand 307
Virgin Forest Areas 308
Virginia and West Virginia State Line 327, 351, 352
Virginia Geological Survey 25
Volcanic Breccia 294
Volcanic Breccia, Igneous Dike of Altered and Extremely Weathered (Chapter VI) 266-273
Volume IV (W. Va. G. S.)......... .... 274, 275, 277, 278, 279
Volume V (W. Va. G. S.) 308

W

Wagner Run 43, 44
Wagner Knob 143, 275
Wagner Knob, Iron Ore Prospect.... .... 275, 277, 278
Warner, Mr. 304
Warped (Anticlines and Synclines)..227
Warping 23, 25
Water 310
Water, Caution Regarding 303-4
Water for Domestic Purposes 301-5
Water-Power 52-59
Water-Power and Physiography (Chapter II) 23-59
Water-Power, History, and Physiography (Part I) 1-59
Water-Power Resources of West Virginia 57
Water, Rain- 302
Water Resources Branch of U. S. G. S. 57
Water, River 301, 304
Water, Soft 303
Water, Sulphurous 303
Water-Supplies, Municipal 304-5
Water-Supply, Circleville 304
Water-Supply, Franklin 304-5
Water, Surface 302
Water Tests 305
Waterways 2, 3
Waverlyan 188
Wear (Abrasion) Tests 300
Weathering of Rocks 305
Webster Springs Sandstone.......... ....193, 194, 196, **198**
Webster Springs Sandstone (Falls) (Plate XLVII) 198
Weese 334

Page.
Weight, Iron Ore 277
Weight, Sandstone and Limestone...300
Weimer's Blacksmith Shop.........354
Weir Sand 180
Wellersburg-Stony River Synclinal Area
................**238-40**, 264, 265
Wellersburg Syncline 240
Wells 301, 303
West From Franklin (Trip) 259-265
West of North Fork Mountain:
Bloomsburg 120
Bossardville 126
Catskill 174-6
Chemung 171
Clinton 106-7
Genesee 160-2
Greenbrier 187-191
Hamilton 154
Helderberg 134
Limestone 286-7
Marcellus 149
Niagara 116
Oriskany 141-2
Pocono 178-181
Pleistocene and Recent System 218-219
Portage 167
Pottsville 206-213
Rondout 124
Salina 120, 124, 126
West Virginia and Virginia State Line
.... 327, 351, 352
West Virginia Photo Co. ....
51, 63, 64, 65, 66, 100, 207, 208, 239
West Virginia University 310
Western Maryland R. R. 2
Western Maryland R. R., Levels......
.... 328-9, 333-4, 337
Wheat 17, 307
Wheels, Overshot ..52, 53, 54, 55, 303
Whetstone Run 46
Whip Cove Anticline 235
White 332
White, J. 329
White Medina, Formations Above the
(Chapter IV) 104-226
White Medina (Sandstone)..........
23, 30, 37, 39, 40, **61-70**, 70, 71, 74, 82, 83, 84, 85, 86, 87, 92, 93, 96, 97, 98, 104, 105, 107, 108, 109, 112,
White Medina (Sandstone):
113, 117, 118, 238, 241, 242, 243, 244, **245**, **246**, 247, 248, 249, 250, 258, 259, 262, 263, 264, 265, 293, 294, 296, 305
White Medina Sandstone:
Areal Distribution 61-67
Contacts 69-70
Economic Character 70
General Character 67-69
Map Symbol (Swm) 61
Thickness 69
White Run 42, 43, 50
Whitethorn Creek ..42, 43, 44, **47**, 236
Whitmer 331
Width, Iron Ores 277
Wilfong Church 168, 170, 224
Wilfong Knob 142, 275
Wilfong Knob, Iron Ore Prospect.....
.... 275, 277, 278
Wilfong School ..49, 153 162, 220, 338
Wills-Dunning Mountain Anticline...238
Wills Mountain Anticlinal Area....237-8
Wills Mountain Anticline ....
62, 67, 69, 70, 71, 72, 74, 76, 78, 80, 81, 82, 83, 86, 87, 99, 104, 232, **237-8**, 241, 243, 244, 247, 250, 262, 265, **286**, **287**, 302
Wills Mountain Anticline, Limestone..287
Wilson Run 43, 44, 48
Wine Spring School ....
..........327, 348, 349, 352, 353
Winters 10
With Reference to Coal, Oil, and Gas
.... 281-5
Wolf Run 49
Wolfe, G. V. 349
Woodlots 308
Woodrow 329, 334
Wright, Frank J. 25, 35
Wymer 332

Z

Zeke Run 42, 43
Zeolites of Analcite 267, 270
Zigler 19, 278
Zigler, Clinton Iron Ore Analysis....278
Zion Church 349